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Depositional environments and correlation problems of the Wedron Formation (Wisconsinan) in northeastern Illinois

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COVER PHOTO: The Wedron Section, as exposed in the west wall of Pit 6, Wedron Silica Quarry, in 1983.

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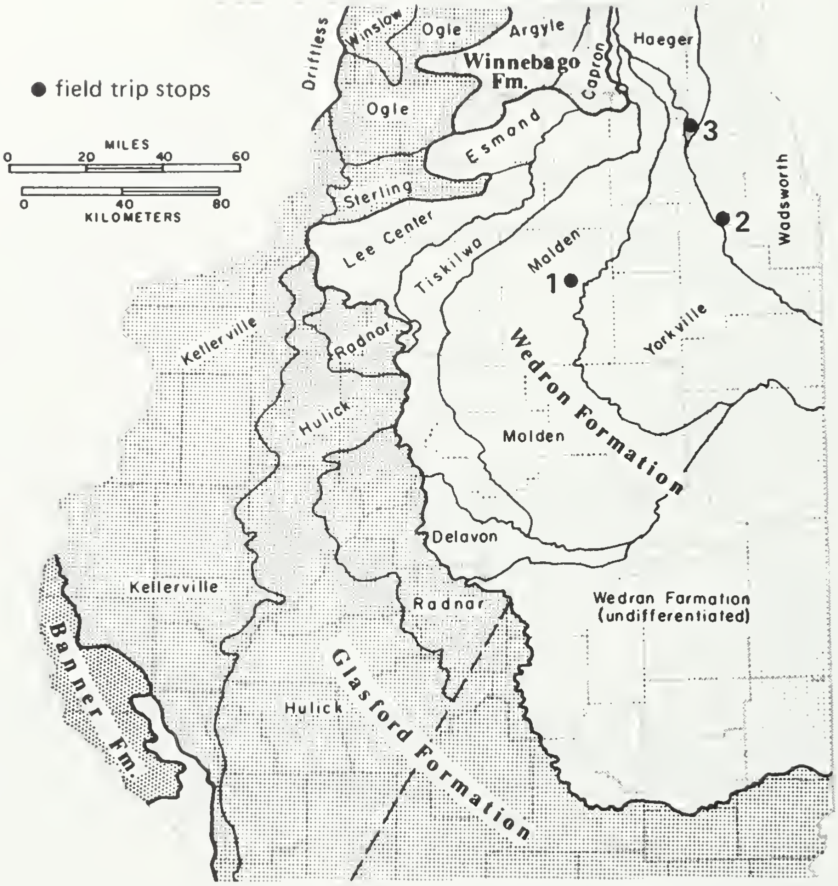

FIGURE 1. Areal distribution of Wedron Formation till members. From Willman and Frye (1970).

INTRODUCTION

Ardith K. Hansel, W. Hilton Johnson, Betty J. Socha, and Leon R. Follmer

Glacial deposits and landforms in northeastern Illinois have attracted the interest of geologists since the early observations of Chamberlin (1882, 1894) and Leverett (1899). Investigations in this area have been central to the development of concepts of the Wisconsinan glaciation. Selection of De Kalb, Illinois, as the location of the 19th Annual Meeting of the North-Central Section of the Geological Society of America provided us with an excellent opportunity to revisit Wisconsinan exposures in this area and to review not only some of the earlier interpretations, but more importantly, to consider and evaluate them in terms of our current understanding of glacial deposits and their origin.

The field trip was planned in conjunction with two symposia at the meeting, one on glacigenic depositional models and the other on sedimentation and stratigraphy of the Lake Michigan Basin during the late Quaternary. We will discuss various aspects of glacial depositional environments and stratigraphic and correlation problems of the Wedron Formation.

THE WEDRON FORMATION: GENERAL BACKGROUND

The Wedron Formation, as defined by Frye and others (1968), includes till and intercalated gravel, sand, and silt of the Woodfordian Substage (late Wisconsinan). It comprises the succession of Woodfordian deposits that extend upward from the basal contact with Morton Loess to the top of till below the Two Creeks deposit at Two Creeks, Wisconsin. The Wedron Formation was named for Wedron, La Salle County, Illinois. The Wedron Section, exposed in the Wedron Silica Quarry (SE SW Sec. 9, T. 34N, R. 4E), was designated the type section (Frye et al., 1968).

The geographic distribution, spatial relations, and subdivisions (members) of the Wedron Formation in Illinois, as conceived by Willman and Frye (1970), are shown in figures 1 and 2. In the field trip area in northeastern Illinois, five till members of the Wedron Formation were differentiated: the Tiskilwa, Malden, Yorkville, Haeger, and Wadsworth Till Members (fig. 1). Two older members, the Esmond and Lee Center Till Members, were defined and mapped farther west; Delavan was defined and mapped to the south.

Willman and Frye (1970) considered three alternatives in establishing a formal lithostratigraphic classification for the Quaternary deposits in Illinois: (1) a large formation differentiated into many members; (2) several formations differentiated on the basis of lithology and key beds (buried soils) and subdivided into members; or (3) many formations differentiated on the basis of lithology and generally equivalent to the type of unit they established at the member rank. They elected to adopt the second alternative because they considered the first to be of limited usefulness and felt the last would create too many formations, many of which might lack regional continuity. Some of their formations were bounded by buried soils and these lithostratigraphic units are close in concept to units that were also defined as chronostratigraphic units. For example, the glacial deposits of the Woodfordian Substage

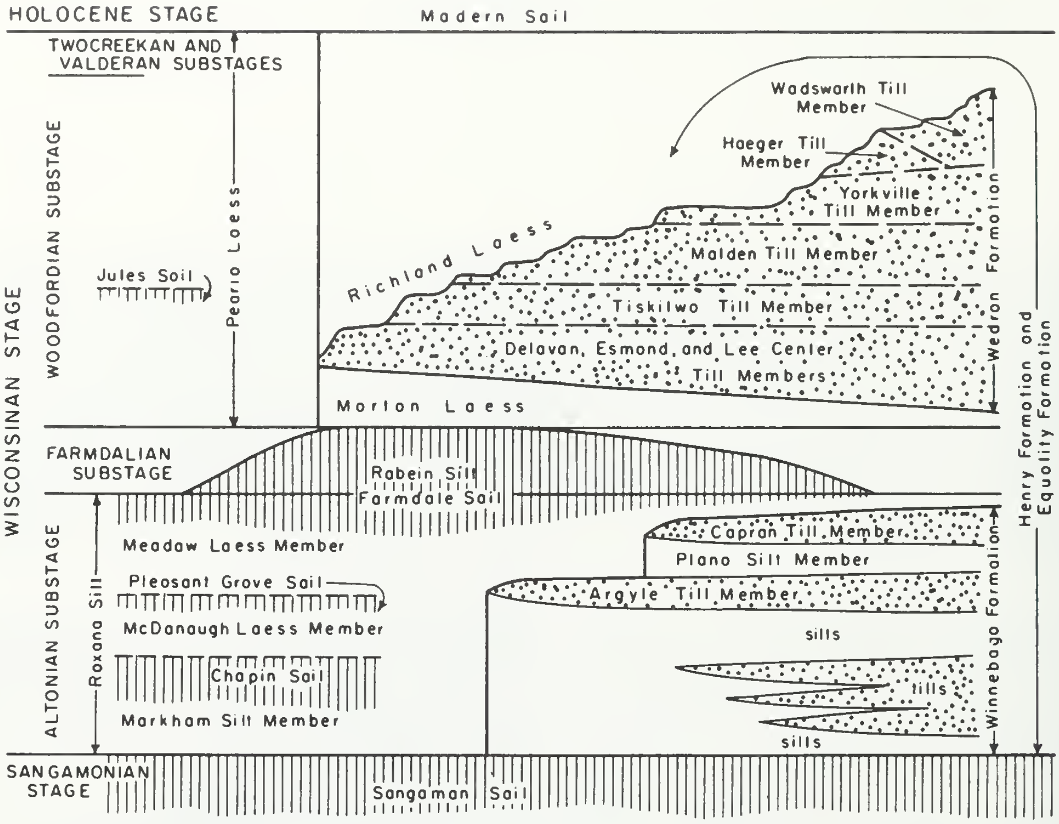

FIGURE 2. Relationship of Wisconsinan formations and members in northern and western Illinois. From Willman and Frye (1970).

were grouped into one formation, the Wedron, and distinct subunits were established at the member rank.

In the 15 years since Willman and Frye published the classification, Quaternary researchers in Illinois have found that the formations are not, in all cases, the most functional field units: in many cases, the more useful lithostratigraphic units have proved to be those defined as members (e.g., the Tiskilwa, Malden, Yorkville, Haeger, and Wadsworth Till Members of the Wedron Formation). For this reason, possible revisions in the classification of the Wedron Formation are being considered and some member units are being evaluated to determine if they meet criteria for formational rank.

FIELD TRIP ORIENTATION

During this field trip we will examine all the members of the Wedron Formation in northern Illinois except the Yorkville Till Member.

Stop 1 will be in active pits of the Wedron Silica Quarry where the type section of the formation was described. At Wedron, our focus will be on depositional environments as inferred from the diverse succession of deposits exposed and on stratigraphic problems related to the basal unit of the formation, the contact between the Tiskilwa and Malden Till Members, and subunits within the Malden.

Stop 2 will be at the type section of the Lemont drift along the Des Plaines River valley where the Wadsworth Till Member overlies Lemont drift. The Lemont was prominent in the literature some 30 years ago and is receiving renewed attention because of proposed correlations to the Malden Till Member and/or the Haeger Till Member. We will discuss problems presented by the Malden-Lemont correlation, and the strong lithologic contrast between the Wadsworth and Lemont diamictons.

Stop 3 will be in a large gravel pit near Elgin where outwash and diamicton of the Haeger Till Member are exposed. The stop is located in a critical area. It is in the southernmost area of mapped Haeger Till (fig. 1) and in an area of complex geomorphic relationships among the Fox River valley, the Minooka Moraine, and the West Chicago Moraine (map, back cover). The discussion will focus on the Lemont-Haeger correlation and on sedimentological characteristics of the deposits.

FIELD AND LABORATORY METHODS

We have used textural terminology established by the Soil Conservation Service, U.S. Department of Agriculture, for section and unit descriptions. Color names and designations from the Munsell System are used for moist samples.

Pebble fabrics were determined by measuring the orientation of the long axes of prolate-shaped pebbles and the orientation of the plane defined by the long and intermediate axes of blade- and disc-shaped pebbles. Petrofabric diagrams are based on the dip direction of the plane of blade- and disc-shaped pebbles and/or the azimuth and plunge of the long axis of prolate-shaped pebbles. Measurements of the orientation of pebbles were plotted on lower hemisphere equal-area nets using a computer program written by C. E. Corbato of Ohio State University and revised by D. E. Lawson. Densities of poles were contoured at two standard deviations, using the method of Kamb (1959). Pebble orientations were evaluated statistically by using a computer program, written by D. E. Lawson, which uses the eigenvalue method described by Mark (1973, 1974). The method produces three mutually perpendicular eigenvectors V_1, V_2 and V_3. The longest eigenvector (V_1) represents the mean axis and indicates the direction of maximum clustering; V_3, the smallest eigenvector, represents the direction of minimum clustering. The significance value S_1 indicates the strength of clustering about V_1; S_3 indicates the strength of clustering about V_3. Tables provided by Mark (1973, 1974) were used to test S_1 and S_3 to determine if V_1 and V_3 are different from values derived from a random sample of a uniform population. Significance at the ≤ 0.05 level is noted in table 1, which summarizes fabric results.

Grain size analyses of selected samples were determined in the Geotechnical Laboratory of the Illinois State Geological Survey (ISGS), using standard hydrometer, pipette, and sieve techniques. Data are reported as percentage of gravel (> 2-mm fraction) of the whole sample, and percentage of sand (0.062-2 mm), silt (4- to 62 -µm) and clay (< 4 -µm) in the matrix (< 2-mm fraction). Clay minerals were analyzed and determined by H. D. Glass of the ISGS, utilizing X-ray diffraction methods with oriented aggregate, glycolated slides of < 2-µm material. Clay mineral data are expressed as percentage of expandable clay minerals (all materials, including low-charge vermiculite and smectite, that expand to approximately 17 Å when solvated with ethylene glycol), percentage of illite (all minerals of 10 Å basal spacing that do not expand when treated with ethylene glycol), and percentage of kaolinite plus chlorite (all minerals with a 7.2 Å basal spacing). The amount of calcite and

TABLE 1. Results of analyses of pebble fabric in lithofacies at Wedron and Elgin.

Fabric number	Lithofacies	Genetic name	V_1(°) azimuth; plunge	S_1	V_3(°) azimuth; plunge	S_3
Wedron--Wedron Silica Quarry						
1	Dm(s)	till	59;55	0.652	252;34	0.088
2	Dm	sed. flow d.	43;47	0.484*	191;39	0.181*
3	Dm	lac. d.	58;10	0.541	322;28	0.142
4	Dm	till	221;04	0.614	321;68	0.111
5	Dm(s)	till	144;59	0.646	356;27	0.121
6	Dm(s)	till	102;78	0.733	256;11	0.094
7	Dm	till	316;81	0.682	152;09	0.114
8	Dm	till	103;61	0.607	303;28	0.164
9	Dm(r)	sed. flow d.	155;74	0.509*	272;08	0.200*
10	Dm	lac. d.	158;48	0.507*	48;16	0.188*
11	Dm	till	40;18	0.546	221;72	0.150
12	Dm(s)	till	64;87	0.798	238;03	0.065
25	Dm(s)	till	91;14	0.612	338;58	0.078
Elgin--Beverly Sand and Gravel						
13	Dm(r)	sed. flow d.	76;19	0.437*	176;27	0.262*
19	Dm(r)	sed. flow d.	169;73	0.467*	260;00	0.164
22	Dm	till	100;17	0.923	1;27	0.035
23	Dm	till	83;08	0.925	329;71	0.014
24	Dm	till	99;09	0.911	262;81	0.019
26	Dm	till	80;16	0.877	171;03	0.040
27	Dm(r)	sed. flow d.	41;00	0.572	310;74	0.090
28	Dm	till	71;19	0.899	228;69	0.037
29	Dm	till	92;05	0.701	346;71	0.100
30	Dm	till	58;22	0.632	245;65	0.103
31	Dm(s)	till	100;13	0.935	332;70	0.027
32	Dm(r)	sed. flow d.	4;34	0.471*	213;52	0.182*
33	Ds	till	252;06	0.664	48;84	0.104
34	Dm	till	71;05	0.952	227;85	0.008
35	Dm	till	80;13	0.891	213;71	0.025

*Indicates the value is not significant at the $\leq$ 0.05 level. At the $\leq$ 0.005 significance level, S_1 is significant at $\geq$ 0.512 (n=25); S_3 is significant at $\leq$ 0.169 (n=25). Note that whereas large values of S_1 indicate greater fabric strength, smaller values of S_3 indicate greater strength (Mark, 1973, 1974).

dolomite in the < 74-µm fraction of selected samples was determined on the Chittick apparatus, utilizing techniques described by Dreimanis (1962).

A lithofacies code (table 2) similar to that developed by Eyles and others (1983) is used in figures and diagrams. The capital letters G, S, ST, and C are used for deposits dominated by gravel, sand, silt, and clay, respectively; D is used for diamicton. Lower case letters are used to further describe the lithofacies (more than one can be used). Because most of the diamictons that we describe are matrix-supported, this property is not included in the code.

FACIES AND DIAMICTON GENESIS

Genetic differentiation of sediments and recognition of lithofacies variability are essential to environmental interpretation and also strengthen stratigraphic correlation of glacigenic and related deposits. Lithofacies assemblages, vertical profiles, and lateral relationships are described and used in combination with pebble fabric and laboratory-derived data (primarily grain size and clay mineral composition) to characterize stratigraphic units and reconstruct probable depositional environments.

Nomenclature used in the description of units and sections is intended to be descriptive rather than genetic. The term diamicton was introduced by Flint and others (1960a, 1960b) to fill the need for a general, descriptive term for poorly to nonsorted sediment, regardless of the mode of origin. The term is used to indicate only a range of particle sizes and does not specify relative abundance of any or all size classes. The term implies that both coarse clasts (2 mm or larger) and matrix are present (Frakes, 1978). Clasts should be present in sufficient numbers to be considered conspicuous and may be dispersed throughout the matrix or may be in contact with each other. By this definition, sediment originating from a variety of processes could be described as diamicton (e.g., till, sediment flow deposits, rock avalanche debris, and subaqueous debris flow deposits).

TABLE 2. Lithofacies code summary.

Diamicton, D:
- m: massive
- s: stratified
- g: graded

Gravel, G:
- m: massive
- h: crude horizontal bedding
- g: graded bedding
- x: cross-bedding
  - x-p: planar
  - x-t: trough

Sand, S:
- m: massive
- h: horizontal bedding
- g: graded bedding
- x: cross-bedding
  - x-p: planar
  - x-t: trough
- r: rippled

Silt, ST:
- m: massive
- l: laminated
- g: graded bedding
- r: rippled
- p: pebbly

Clay, C:
- m: massive
- l: laminated
- p: pebbly

Genetic interpretation: evidence for:
- (r): resedimentation
- (d): soft sediment deformation
- (s): shearing
- (c): current reworking
- (p): pedogenesis

We have used the term diamicton for deposits in which the matrix contains about equal proportions of sand, silt, and clay, and for deposits in which the matrix contains only a small percentage (about 10%) of one of these fractions. Alternatively, the latter deposits could be described as pebbly silty clay or bouldery sandy silt, for example.

The term till is a specific genetic term referring to sediment aggregated by and deposited directly from glacier ice without subsequent disaggregation and resedimentation (Lawson, 1981). By this definition the major processes by which till is deposited are lodgement and meltout.

We assume here that the process of lodgement involves mechanical lodging of basal debris beneath moving ice that is at the pressure melting point. Lawson and Kemmis (1983), Dreimanis (1976), Boulton and Paul (1976), and others have summarized the characteristics by which till resulting from lodgement can be recognized in Pleistocene sequences. These characteristics include overcompaction, fissility or foliation, massive structure, pebble fabric oriented parallel to glacier flow, a predominance of coarse clasts derived from local sources, erosional lower contacts, and uniform texture with little interbedded sorted sediment. Evidence for glacial shear or traction includes bedding plane shears, basal grooves, consistently oriented "bullet" boulders, rafting and deformation of underlying material, and smudging and shear attenuation of softer lithologies (Eyles et al., 1983).

The meltout process, which can occur subglacially or supraglacially, releases sediment from stagnant glacier ice, often beneath a layer of overburden. Characteristics of meltout till, summarized by Shaw (1982) and Lawson and Kemmis (1983), include nonuniform texture, the presence of lenses of sorted sand and gravel, diffuse laminations consisting of subtle color, grain size, or lithologic changes, overturned block inclusions of sorted sediment, layers of sorted sediment draped over boulders, and a unimodal pebble fabric with pebble dips lower than those found in associated lodgement till.

Diamictons are also deposited in the glacial environment by sediment flow. Sediment flow is the downslope movement of mixtures of sediment and water under the force of gravity. The process produces deposits that may have the following characteristics: a basal zone of traction gravel, a variable texture, a lack of fabric consistently oriented parallel to the direction of ice flow, dipping or undulating basal contacts, and a greater gravel-size clast concentration than in associated till (Lawson, 1983). Flow noses, rafts of fine-textured laminae, silt and clay stringers, rip-ups, basal grooves, pebble imbrication or clusters, random pebble fabric or fabric parallel to bedding, and inclusions of underlying material are distinctive structures of sediment flows reported by Eyles and others (1983). Sediment flow deposits commonly are associated with sorted deposits and the sediment assemblage may contain structures that are the result of collapse due to the melting of underlying ice.

A single criterion cannot be used to differentiate diamicton resulting from lodgement, meltout, or sediment flow. Suites of sediment characteristics, however, are useful to infer a likely process of deposition and will be used in interpretive discussions of the units at Wedron (Stop 1) and Elgin (Stop 3).

Pebble fabric of deposits is useful in the genetic interpretation of diamictons. Pebble fabrics in modern glacial environments have been described by Boulton (1971), Lawson (1979), Domack (1982), Mills (1977), and others. Boulton's work indicated that the long axes of pebbles in the main body of debris flows tend to lie parallel to flow direction whereas at the front of flows, long axis alignment is transverse to flow. Pebbles in both positions have a fairly strong preferential orientation. Although Lawson (1979) reported that preferential orientation of pebbles tends to increase with increasing water content of the sediment flow, most sediment flow deposits were characterized by a fairly weak preferential orientation of pebbles. Although preferential pebble orientation either parallel or transverse to the ice flow direction has been described in till, parallel orientation appears to be more prevalent. Lawson (1979) reported parallel orientations in basal meltout till and Mills (1977) found little tendency for transverse orientation in alpine basal tills. Boulton (1971) related transverse orientation to compressive ice flow, but Lawson (1979) found parallel orientations in zones of both compressive and extending ice flow. Most researchers reported relatively strong preferential orientation of clasts in basal tills and a weak to strong preferred orientation of dip upglacier.

CURRENT STATUS OF MEMBERS OF THE WEDRON FORMATION IN NORTHERN ILLINOIS

LEE CENTER AND ESMOND TILL MEMBERS

Investigations by Follmer et al. (1978), Berg et al. (1985), and J. P. Kempton (personal communication) have shown that in a few locations the Sangamon Soil is present in the Lee Center and Esmond Till Members in their type areas. Thus, these units are older than deposits of the Wedron Formation and at this time are considered to be part of the Glasford Formation of the Illinoian Stage. Their stratigraphic classification will be discussed at the Midwest Friends of the Pleistocene Field Conference scheduled for May 17-19, 1985, in Rockford, Illinois.

TISKILWA TILL MEMBER

The lowermost unit of the Wedron Formation consists largely of thick, uniform, red-gray clay loam diamicton that contains less illite than most other Lake Michigan Lobe diamictons in Illinois. A more variable zone, often grayer and containing more illite and less clay, occurs in some places at the base of the Tiskilwa; it seems to be best classified as a basal facies of the Tiskilwa Till, probably resulting from incorporation of local bedrock and older drift (Wickham and Johnson, 1981). Sorted sediment interbedded with diamicton of more variable texture is commonly present at the top of the Tiskilwa. This upper facies, referred to as ablation till by S. Wickham (1979), is the result of sedimentation in supraglacial and ice-marginal environments. Deposits of similar origin occur locally with the other units described below, but will not be specifically discussed here.

The lower boundary of the Tiskilwa Till Member is distinct where it is underlain by Morton Loess, Robein Silt, or grayish units of the Glasford Formation (Illinoian). It is difficult to distinguish when it is underlain by pinkish diamictons of the Winnebago Formation (Altonian and/or Illinoian). The upper boundary--Tiskilwa-Malden contact--usually is distinct because of the contrast in color. Locally, where the Malden contains incorporated Tiskilwa drift, the contact is more difficult to differentiate, particularly in the subsurface.

On the whole, however, the Tiskilwa is a widespread, mappable lithostratigraphic unit and could be increased in rank to formational level.

MALDEN TILL MEMBER

The Malden Till Member consists of a complex of gray to gray-brown diamictons, loam to silty clay loam in texture, that are interbedded with sorted sediments. Diamictons within the Malden vary in texture vertically and laterally. The clay fraction contains more illite than does that of the underlying Tiskilwa Till Member, and generally less illite than the clay fraction of the younger Yorkville Till Member. Sorted sediments between diamictons in the Malden probably reflect proglacial deposition; an actively fluctuating ice margin is indicated during the deposition of the Malden Till Member (Willman and Frye, 1970). A facies that commonly is redder and contains less illite than the main part of the unit is locally present at the base or makes up the entire unit. This facies probably is the result of basal incorporation of Tiskilwa Till and older drift. It was referred to as "Malden Till--mixed composition" by S. Wickham (1979).

The Malden-Yorkville contact is distinct in some areas but not others. In the northeastern part of the Princeton Sublobe (fig. 3), a strong textural contrast exists between Malden loam diamicton and silty clay to silty clay loam diamicton of the Yorkville. South of this area, the textural contrast is less distinct. South of the Illinois River there is little or no textural contrast, and as a result, areas mapped as Malden by Willman and Frye (1970)

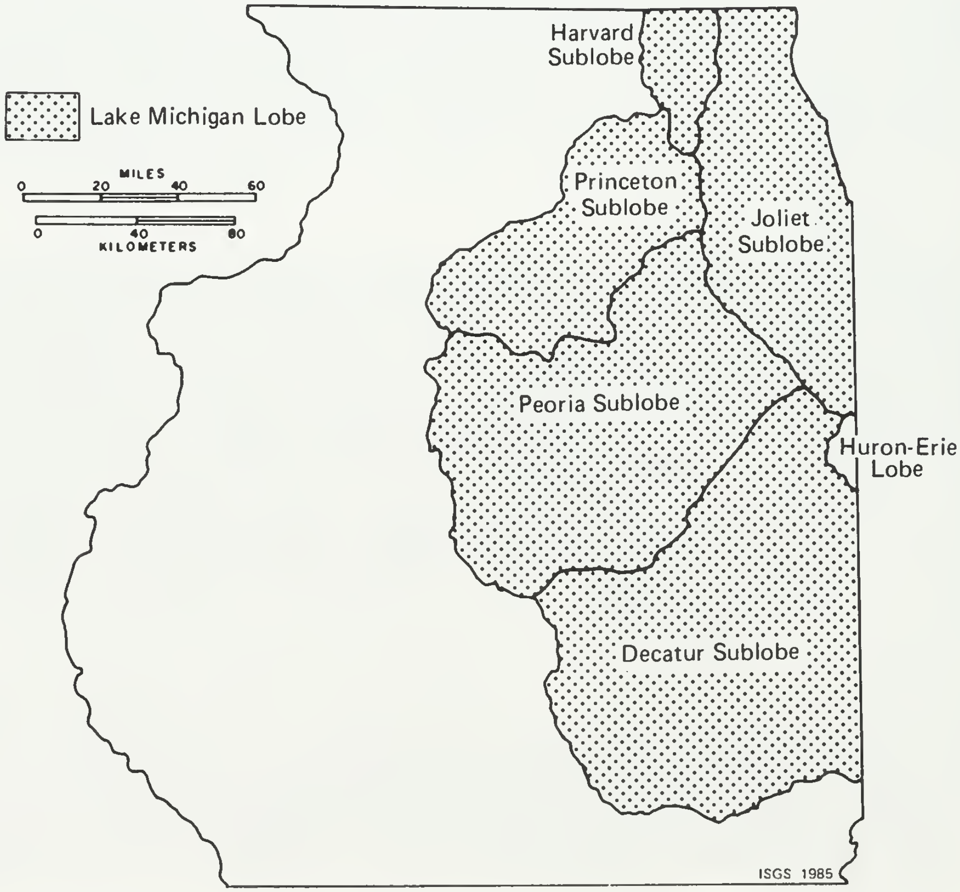

FIGURE 3. Woodfordian glacial sublobes in Illinois. Modified from Willman and Frye (1970).

(fig. 1) were mapped as Yorkville by Lineback (1979) on the state map (fig. 4). This area may be a clayey upper facies of the Malden (Johnson, 1976). The Malden is a complex unit having significant lateral variability and vertical complexity; multiple diamictons are separated by sorted sediment. Revision of the Malden cannot be accomplished until these aspects of the internal stratigraphy are understood and contact problems are resolved.

YORKVILLE TILL MEMBER

The Yorkville Till Member consists largely of gray, silty clay to silty clay loam diamicton. Sorted sediment, much of which is interpreted as proglacial lake sediment, is also present. Zones with distinctive clay mineral composi-

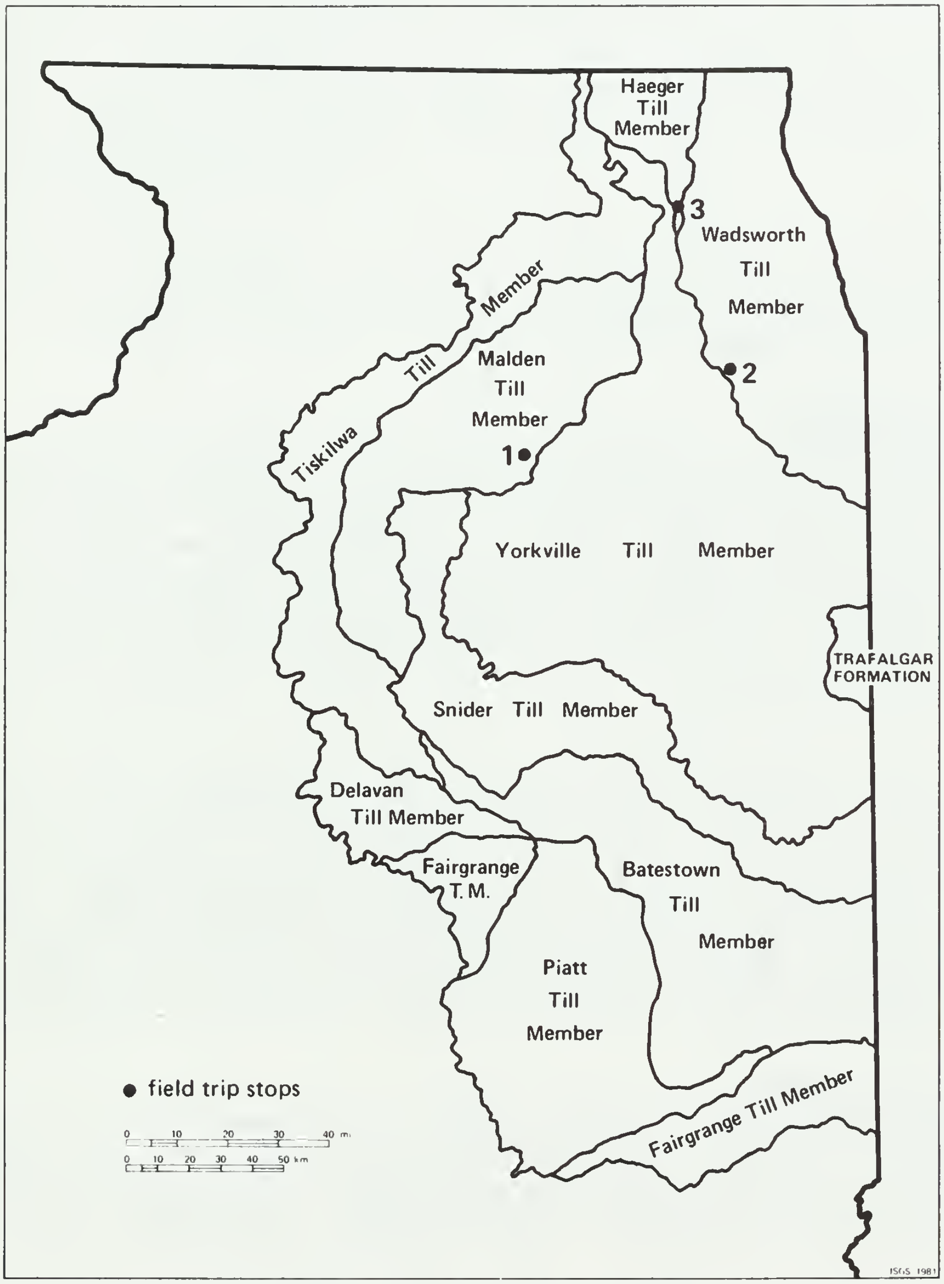

FIGURE 4. Areal distribution of Wedron Formation till members and Trafalgar Formation. After Lineback (1979).

tion have been reported within the Yorkville (Killey, 1982; Killey and Glass, 1985). Most often the changes in clay mineral composition correspond to boundaries between morphostratigraphic units described by Willman and Frye (1970); sorted sediment locally occurs between the mineral zones.

In the Harvard Sublobe, where the Yorkville overlaps the Tiskilwa (fig. 4), Yorkville diamicton locally is characterized by a zone intermediate in color, texture, and clay mineral composition between typical Tiskilwa and typical Yorkville (S. Wickham, 1979). In this area, the Yorkville Till Member is easily differentiated from the basal sand and gravel of the overlying Haeger Till Member. South of the area mapped as Haeger (fig. 4), the clayey Yorkville is overlain by gray, clayey diamicton and sorted sediment of the Wadsworth Till Member. The Yorkville and the Wadsworth units are difficult to differentiate on the basis of field criteria, but Killey and Glass (1985) report a difference in clay mineral composition along the mapped boundary. Concepts developed during preparation for the field trip suggest that some of the area now mapped as Yorkville (figs. 4 and 19) is Wadsworth (See Epilogue).

The Yorkville is a distinct lithostratigraphic unit in the Harvard Sublobe, where it contrasts with adjacent units. South of that area, vertical cutoffs along moraine fronts may be required where it is difficult to differentiate Yorkville from the more clayey facies of the underlying Malden Till and the overlying clayey Wadsworth Till (fig. 4).

HAEGER TILL MEMBER

The Haeger Till Member consists of a lower facies of sand and gravel and where present, an upper (generally thin) facies of loam to sandy loam diamicton that is yellowish brown to gray. The Haeger generally contains less illite than most other Wedron units do. Willman and Frye (1970) defined the upper boundary of the Haeger to be the contact with Wadsworth Till Member, but suggested that the Haeger graded southward into the adjacent clayey diamicton of the Wadsworth. Work by Hansel (unpublished) and Curry and Glass (1985) indicates that in Lake and northern Cook Counties the Haeger is overlain by the Wadsworth Till Member.

The Haeger is a viable lithostratigraphic unit in northeastern Illinois that is easily differentiated from adjacent units. Preliminary work (discussed later) suggests that the Haeger may be traced in the subsurface to the area of Lemont drift (described by Bretz, 1939) along the Des Plaines and Sag channels southwest of Chicago. If this is so, lateral variations in grain size and clay mineral composition occur in this unit. Willman and Frye (1970) suggested the possibility of correlation of the Lemont with the Haeger. Landon and Kempton (1971) and Bogner (1973) correlated the Lemont drift with the Malden Till Member.

WADSWORTH TILL MEMBER

The Wadsworth Till Member consists of gray, fine-grained diamictons and interbedded, sorted sediment. Several units of gray, clayey diamicton have been differentiated on the basis of slight changes in clay mineral composition and texture across moraine boundaries (Hansel, 1983). Deposition of the Wadsworth Till Member probably represents several minor fluctuations of the ice margin.

The Wadsworth is distinct from the underlying and adjacent coarser textured Haeger in northern Illinois, but is less sharply differentiated from the clayey Yorkville Till Member in the area south of where the Haeger is mapped (fig. 4). Willman and Frye (1970) observed that in this southern area the outer margin of the Wadsworth Till was more silty and contained more gravel lenses than either typical Wadsworth or Yorkville. They suggested that these texturally variable deposits might represent a lateral equivalent of the Haeger.

The Wadsworth Till Member is bounded at the top by the Shorewood Till Member of the Wedron Formation, which was defined by Lineback and others (1974) on the basis of sediment cores and seismic profiles from the bottom of Lake Michigan. The contact between these units was not observed in the sediment cores, however; it was interpreted on the basis of morphology derived from seismic study of the lake bottom. The Wadsworth Till Member of Illinois is equivalent to the Oak Creek Formation in Wisconsin (Mickelson et al., 1984; Hansel, 1983). The upper contact of the Wadsworth probably can be best described on the basis of deposits in Wisconsin. Hansel (1983) concluded that in northern Illinois the Wadsworth is a distinct lithostratigraphic unit suitable for formational rank.

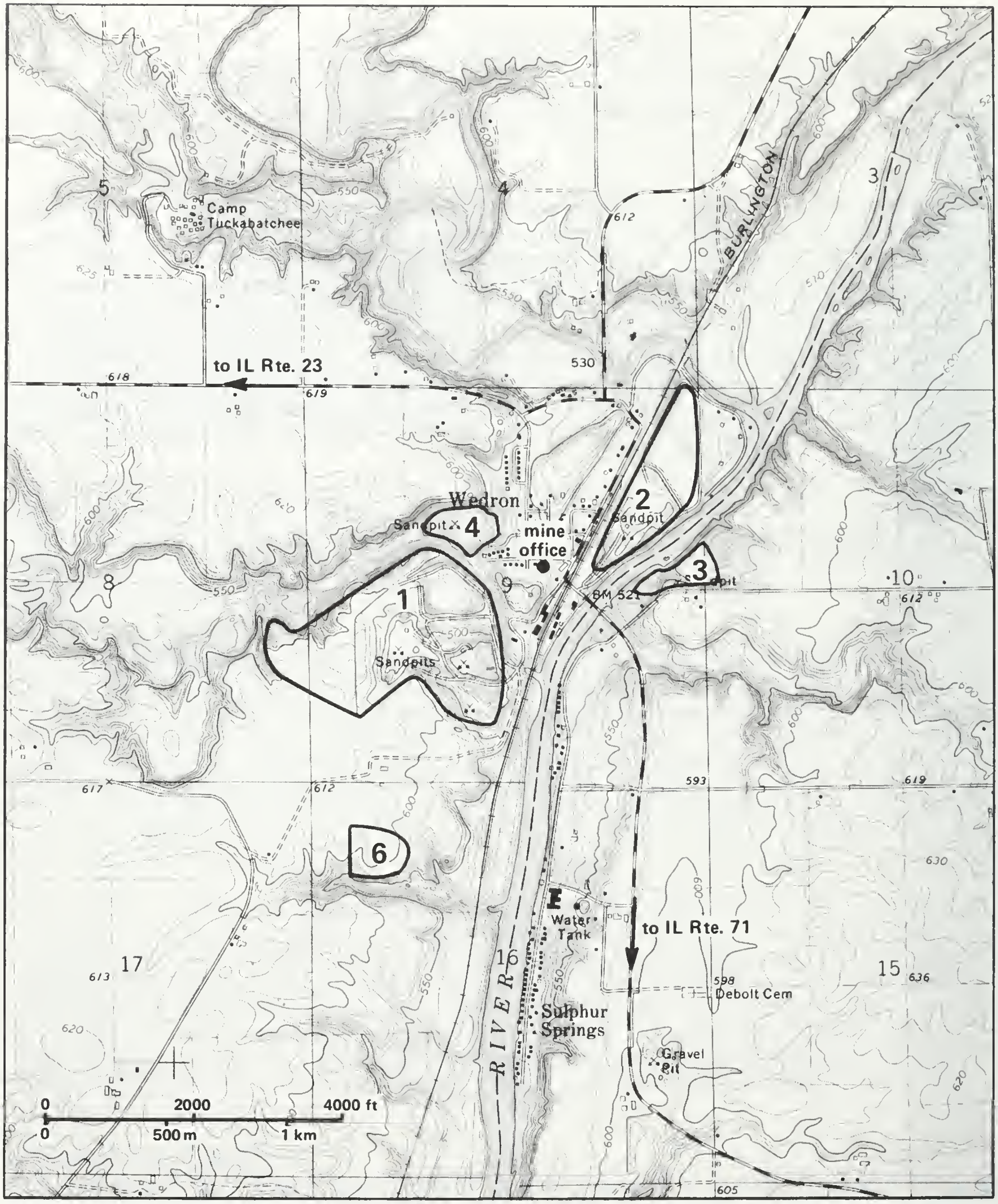

FIGURE 5. Locations of quarry pits at Wedron, La Salle County, Illinois (Secs. 8, 9, 10, and 16, T 34 N, R 4 E; Wedron, Illinois, U.S. Geological Survey, 7.5-minute Quadrangle.

THE WEDRON SECTION: STOP 1

W. Hilton Johnson, Ardith K. Hansel, Betty J. Socha, and Leon R. Follmer

GENERAL BACKGROUND

The Wedron Section has been an important stratigraphic section since early in this century, when quarries were opened to mine the St. Peter Sandstone. Sauer (1916) recognized a till unit and several units of sand and gravel, and silt and clay. H. B. Willman studied the Wedron Section throughout his long career focusing on the stratigraphy of Illinois. His early work was done in association with M. M. Leighton and later he worked closely with J. C. Frye and H. D. Glass. Concepts derived from investigations of the Wedron succession were used in classifying and interpreting Woodfordian glaciation in Illinois.

The early work placed strong emphasis on morphology as a basis for subdividing and naming the glacial deposits. End moraines were recognized as representing ice-margin deposits of a pulsating, active ice sheet, and it was assumed that each end moraine would have a sheet of till associated with it. The succession at Wedron supported the concept: several relatively distinct till units of the last glaciation were exposed, and several end moraines of the last glaciation had been mapped to the west. The till units at Wedron were named for the end moraine with which they were assumed to be related; for example, Willman and Payne (1942) recognized Shelbyville drift (lake deposits), Bloomington drift (outwash, till, and lake deposits), Farm Ridge drift (till), and Marseilles drift (outwash) on the basis of the section as exposed in 1935. Later, Leighton and Willman (1953) described seven tills of the last glaciation--Shelbyville, Bloomington, Metamora, Normal, Cropsey (two units) and Farm Ridge--as well as related deposits. The drift-end moraine concept was formalized by Willman and Frye (1970) with the introduction of morphostratigraphy. At Wedron, they described six "Drifts" based on observations from 1957 to 1965--Atkinson, Bloomington, Dover, Arlington, Mendota, and Farm Ridge. The units were generally the same as those described earlier (1953); nomenclature changes reflected only a change in moraine names. Waterlain deposits separated each drift unit, and the alternating sequence was used to demonstrate the repeated advances and retreats of the ice margin.

Later work also emphasized the lithologic characteristics of the glacial deposits, and again the Wedron Section played a major role. With the introduction of formal lithostratigraphic units, the Wedron Section (table 3) was designated the type section for the Wedron Formation (Frye et al., 1968). This was considered one of the most typical and complete sections, even though the upper part of the formation is missing. Three till members were described at Wedron: Lee Center, Tiskilwa, and Malden (Willman and Frye, 1970). Later, the Wedron Section also was designated the type section for the Peddicord Formation, a succession of lacustrine deposits interpreted as having accumulated in a Farmdalian lake (Willman, Leonard, and Frye, 1971).

WEDRON SECTIONS

Stratigraphic sections currently are exposed in four pits at Wedron (fig. 5). We will visit Pit 1 (fig. 6), where the Wedron and Peddicord type sections were described, and Pit 6 (fig. 7), which best exposes the Woodfordian succession of deposits (fig. 8). Pre-Wisconsinan deposits, mostly Illinoian

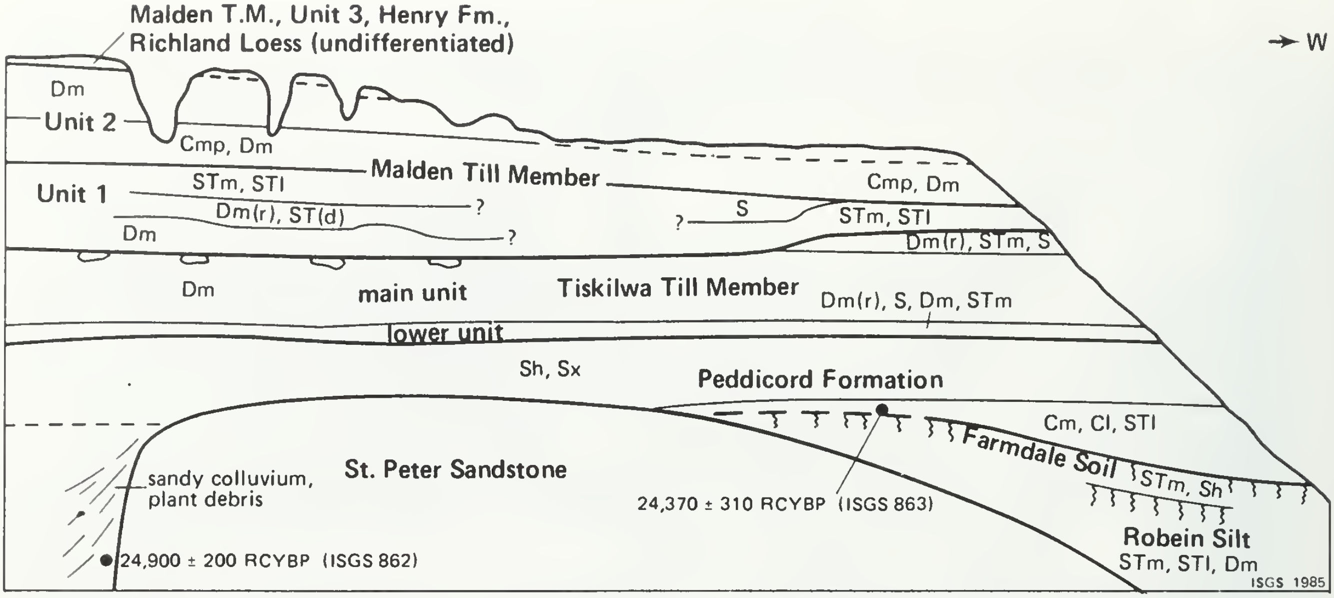

FIGURE 6. Sketch, southwestern corner of Pit 1, Wedron Quarry (not to scale). Units not exposed continuously.

Dm	diamicton, massive
Cm	clay, massive
Cmp	clay, massive, pebbly
Cl	clay, laminated
STm	silt, massive
STl	silt, laminated
Sh	sand, horizontal bedding
Sx	sand, crossbedding
Gh	gravel, horizontal bedding

evidence for

(p)	pedogenesis
(d)	soft sediment deformation
(r)	resedimentation
(s)	shearing

stone line
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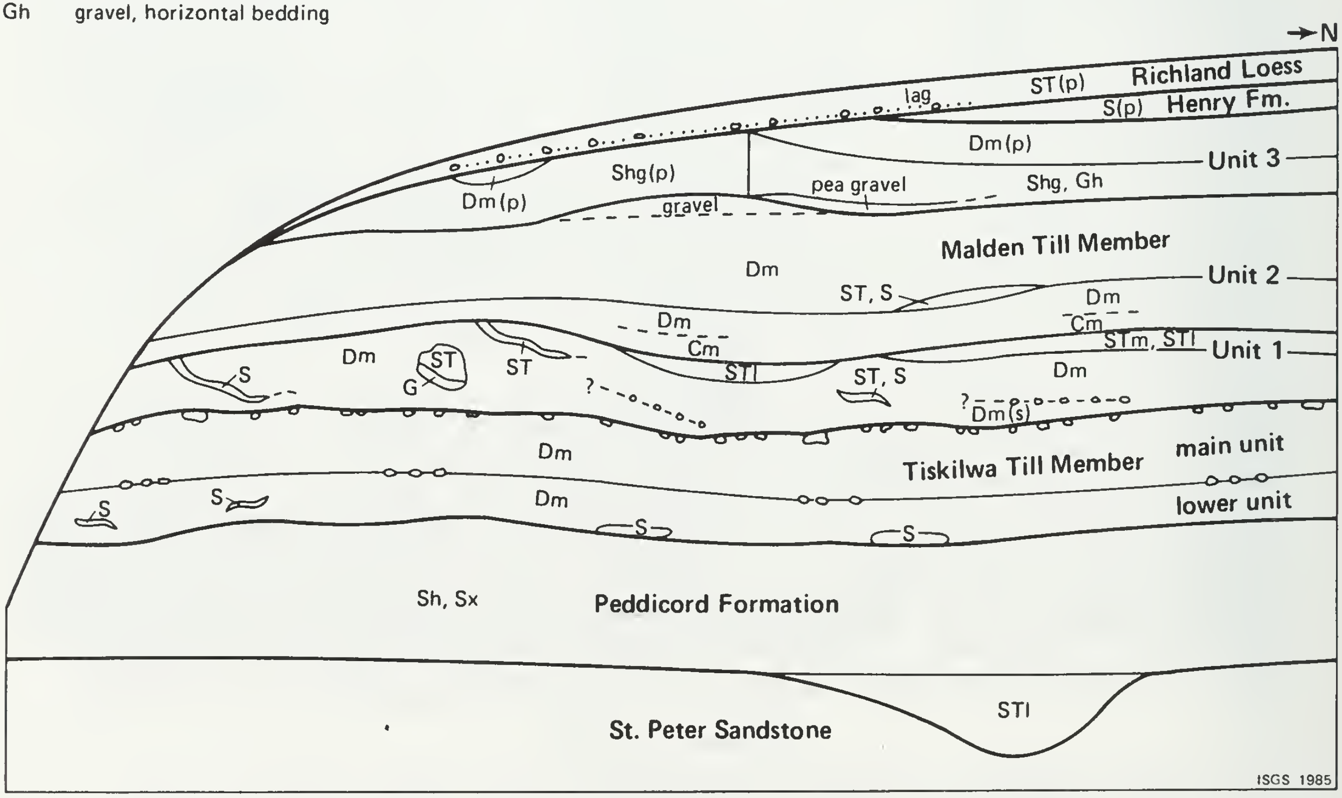

FIGURE 7. Sketch, new west wall exposure, Wedron Quarry, Pit 6, November 1984 (not to scale). Units not exposed continuously.

TABLE 3. Description of Wedron Section by Willman and Frye, 1970.[1]

		Thickness (ft)
	Pleistocene Series	
	Wisconsinan Stage	
	Woodfordian Substage	
	Richland Loess	
15.	Loess, leached; largely included in surface soil	3.0
	Henry Formation	
	Batavia Member	
14.	Sand and gravel, poorly sorted, lenticular	3.0
	Wedron Formation (type section)	
	Malden Till Member	
	Farm Ridge Drift	
13.	Till, silty, yellow-gray, calcareous (P-2082)	4.0
12.	Sand and gravel, calcareous (P-2081)	2.0
	Mendota Drift	
11.	Till, silty, bouldery, gray, calcareous	3.0
10.	Sand, calcareous, tan	0.5
	Arlington Drift	
9.	Till, tan, oxidized, calcareous (P-2080)	5.0
8.	Silt and some sand, laminated, gray, calcareous (P-2078; P-2079 gray clay at top)	2.0
	Dover Drift	
7.	Till, silty, gray, calcareous; contains a few pebbles (P-2077)	3.0
6.	Sand and silt, gray, calcareous	1.0
	Tiskilwa Till Member	
	Bloomington Drift	
5.	Till, pink, bouldery, massive, tough, calcareous; indistinct boulder pavement in middle part (P-2076 middle; P-496 base)	15.0
	Lee Center Till Member	
	Atkinson Drift	
4.	Till, gray and tan, bouldery, compact, calcareous; sharp contact and indistinct bounder pavement at top (P-495, P-2075)	3.0
3.	Sand and gravel, tan, loose, calcareous, locally cross-bedded and generally well bedded; irregular erosional contact at base; thickness varies (maximum thickness given here). (P-494 base)	20.0
	Farmdalian Substage	
	Robein Silt	
2.	Silt, clayey, pink to red and red-brown, calcareous, massive to indistinctly bedded but locally thin bedded and blocky; locally contains small lenses of fine sand; radiocarbon date of 24,000 ± 700 (W-79) determined on wood; conformable on unit below, but upper contact erosional and irregular; thickness varies (maximum thickness given here) (P-491 base; P-492 sand lens; P-493 top)	20.0
1,	Silt, blue-gray and tan, massive, compact, calcareous; contains some clay and fine sand and local sandy streaks near top; contains molluscan fauna described by Leonard and Frye (1960); radiocarbon date of 26,800 ± 700 (W-871) determined on twigs and wood fragments from upper part; some zones strongly contorted by frost action; basal contact is irregular on eroded surface of St. Peter Sandstone (Ordovician); thickness varies (maximum thickness given here) (P-489 middle; P-490 top)	25.0
	Total	109.5

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[1] Measured in overburden of Wedron Silica Co., pit no. 1, SE SW Sec. 9, T 34 N, R 4 E, La Salle County, Illinois, 1957, 1959, 1964, 1965.

drift, are exposed only in Pits 2 and 3; they will not be observed on the field trip.

The general succession of deposits is similar in both Pits 1 and 6, but locally there is considerable variability, and complex sediment relationships exist. Correlations to the Willman and Frye (1970) section are clear in the lower part of the succession but are not clear in the upper part. It appears that the succession now exposed may not be as complete as it was in earlier exposures.

We will describe the general succession of deposits first, then present a more detailed description and interpretation of each stratigraphic unit. Grain-size and clay mineral data are tabulated in table 4.

The Wedron Silica Company quarries the Starved Rock Sandstone Member of St. Peter Sandstone, a thick, quartz sandstone of the Champlainian Series (Middle Ordovician). The sandstone is medium grained, cross-bedded, and friable, except for an outer case-hardened surface. It is used as a silica or industrial sand and for other purposes. Over 30 m of St. Peter is exposed in Pit 1.

The bedrock surface contains several valleys that are tributaries of the Ticona Bedrock Valley (Willman and Payne, 1942). The Ticona River was a major west-flowing stream, but the valleys at Wedron were part of an east-flowing tributary system that eventually drained south and joined the Ticona in western Grundy County.

The Robein Silt is the oldest Wisconsinan unit exposed at Wedron. It consists largely of organic material and silt of alluvial or slackwater origin, and is overlain by gray and pink lacustrine sediment of the Peddicord Formation. A thick sequence of sand overlies the lacustrine deposits. The silt, lacustrine deposits, and sand occur as fill in tributary valleys of the Ticona Bedrock Valley.

Overlying the sand is a thin, gray diamicton with interbeds of sorted sediment and a red-gray, massive, uniform diamicton; both are included in the Tiskilwa Till Member of the Wedron Formation. A complex gray unit, the Malden Till Member of the Wedron Formation, overlies the Tiskilwa; it consists of diamictons and interbedded, sorted sediment. Expansion of Pit 6 in 1984 exposed a younger diamicton (Malden ?) that has not been studied in much detail. Sand and gravel (Henry Formation) locally overlies the Malden; however, much of the sand and gravel extends in the subsurface beneath the recently exposed diamicton and appears to have been exhumed where the diamicton is missing in section. The Richland Loess is at the surface, and the upper part of the Modern Soil is developed in it.

ROBEIN SILT

Buried tributary valleys eroded into bedrock are present in Pit 1 (fig. 6) and are filled with Wisconsinan alluvial and lacustrine deposits. The alluvial deposits are texturally variable but generally are silty and are included in Robein Silt. A truncated, buried soil is present within the succession, and the lower portion of the succession may be Sangamonian or older. The clay mineral composition of these lower deposits (table 4) is similar to that of local Pennsylvanian shale (H. D. Glass, personal communication), suggesting that the deposits were derived largely from local bedrock.

TABLE 4. Grain size and clay mineral data[1] for Wedron Section.

Stratigraphic unit	Lithofacies	Genetic interpretation	% gvl[2]	Grain size matrix[3] % Sd	% Si	% C	Clay mineral composition[4] % E	% I	% K+C	Sample number	
Malden Unit 3	Dm	Till and/or sediment flow deposits	tr	6	28	66	*12	76	12	W-9B-1	(1)[5]
	Dm(r)		tr	12	33	55	*11	78	11	W-9B-2	(1)
			tr	14	28	58	*13	78	9	W-9B-3	(1)
			0	5	29	66	* 7	75	18	6-2-31	(6)
			3	5	29	66	* 7	77	16	6-2-32	(6)
		Average	-	9	29	62	*10	77	13		
		range	0-3	5-14	28-33	55-66	7-13	75-78	9-18		
					n = 5			n = 5			
			-	-	-	-	11	70	19	9-84-9	(6)
Malden Unit 2	Dm(r)	Sediment flow deposits	28	38	38	24	12	73	15	6-2-28	(6)
			4	35	41	24	8	67	25	6-2-27	(6)
			26	4	62	34	3	77	20	6-2-26	(6)
			7	28	68	4	7	64	29	6-2-25	(6)
		Average	16	26	52	22	8	70	22		
		range	4-28	4-38	38-68	4-34	3-12	64-77	15-29		
					n = 4			n = 4			
			8	32	46	22	5	76	19	WHJ-83-79	(6)
	Dm	Till (meltout)	8	35	43	22	3	77	20	WHJ-83-80	(6)
			5	28	50	22	*14	78	8	W-9A-2	(1)
			11	26	45	29	*11	81	8	W-9A-3	(1)
			21	34	44	22	15	73	12	W-9B-4	(1)
			6	33	48	19	6	71	23	W-9B-5	(1)
			13	29	48	23	4	81	16	W-9B-6	(1)
			3	35	47	18	11	72	17	9-84-10	(6)
			16	38	43	19	11	72	17	9-84-11	(6)
			33	33	46	21	6	78	16	9-84-12	(6)
			9	36	47	17	8	66	26	6-2-24	(6)
			10	35	48	17	9	67	34	6-2-23	(6)
			8	33	49	18	4	75	21	6-2-22	(6)
			14	37	37	26	5	70	25	6-2-21	(6)
		$\bar{x}$	12	33	46	21	7	73	20		
		σ	8	3	3	3	4	4	6		
					n = 14			n = 12 (unoxidized)			
			-	-	-	-	4	77	19	WHJ-83-81	(6)
	Dm	Lacustrine deposits with ice-rafted pebbles	3	13	40	47	*13	80	7	W-9A-4	(1)
			1	8	33	59	*12	80	8	W-9A-5	(1)
			2	11	36	53	5	76	19	W-9B-7	(1)
			3	11	34	55	6	77	17	9-84-13	(6)
			2	5	31	64	6	73	21	9-84-14	(6)
			tr	12	39	49	5	72	23	6-2-20	(6)
			0	3	29	68	4	69	27	6-2-19	(6)
			0	6	34	60	4	71	25	6-2-18	(6)
		Average	1	9	34	57	5	74	22		
		range	0-3	3-13	29-40	47-68	4-6	69-77	17-27		
					n = 8			n = 7 (unoxidized)			

TABLE 4. *Continued*

Stratigraphic unit	Lithofacies	Genetic interpretation	% gvl[2]	Grain size matrix[3]			Clay mineral composition[4]			Sample number	
				% Sd	% Si	% C	% E	% I	% K+C		
Malden Unit 2	Cm	Lacustrine deposits	-	-	-	-	4	77	19	WHJ-83-82	(6)
			1	4	29	67	*10	82	8	W-9A-6	(1)
			1	3	21	76	*10	83	7	W-9A-7	(1)
			1	3	31	66	6	77	17	9-84-15	(6)
			0	0	47	53	4	73	23	6-2-17	(6)
		Average	1	2	32	66	5	75	20		
		range	0-1	0-4,	21-47,	53-76	4-6,	73-77,	17-23		
					n = 4			n = 2 (unoxidized)			
Malden Unit 1	STp, STm	Lacustrine deposits	-	7	70	23	12	69	19	WHJ-83-83	(6)
			2	12	65	23	11	71	18	9-84-16	(6)
			0	1	73	26	12	70	18	9-84-17	(6)
			-	-	-	-	18	62	20	9-84-18	(6)
			0	4	75	21	9	65	26	6-2-16	(6)
			0	12	77	11	9	63	28	6-2-14	(6)
		Average	-	7	72	21	12	67	21		
		range	0-2	1-12,	65-79,	11-26	9-18,	62-71,	18-28		
					n = 5			n = 6			
	Dm(r) (interbedded w/STl, STm)	Sediment flow deposits	8	38	36	26	19	72	9	W-9A-8	(1)
			9	33	38	29	12	69	19	W-9A-9	(1)
			5	31	41	28	8	71	21	W-9A-10	(1)
			7	29	35	36	12	63	25	6-2-15	(6)
				40	33	27	14	63	25	6-2-13	(6)
			10	29	47	24	14	60	26	6-2-12	(6)
		Average	8	33	38	29	15	66	19		
		range	5-10	29-40,	33-47,	24-36	12-19,	56-72,	9-27		
					n = 6			n = 6			
	Dm	Till and sediment flow deposits	5	42	30	28	10	71	19	W-9A-12	(1)
			8	39	34	27	13	67	20	W-9A-13	(1)
			19	29	45	26	7	69	24	WHJ-83-85	(6)
			7	39	32	29	7	72	21	WHJ-83-84	(6)
			42	42	36	22	18	65	17	9-84-19	(6)
			10	44	41	15	14	61	25	6-2-11	(6)
		Average	15	39	36	21	11	68	21		
		range	5-42	29-44,	30-45,	15-29	7-18,	61-72,	17-25		
					n = 6			n = 6			
Tiskilwa Main Unit	Dm	Till (lodgement)	4	30	38	32	16	65	19	W-9A-14	(1)
			4	30	36	34	16	64	20	W-9A-15	(1)
			9	29	37	34	16	64	20	W-9A-16	(1)
			6	29	35	36	14	66	20	W-9A-17	(1)
			10	27	37	36	12	65	23	W-9E-1	(1)
			7	28	35	37	11	64	25	WHJ-83-86	(6)
			6	32	34	34	20	63	17	9-84-20	(6)
			5	31	36	33	19	62	19	9-84-21	(6)
			3	30	35	35	18	61	21	9-84-22	(6)
			3	31	35	34	16	59	25	9-2-10	(1)
			18	28	37	35	16	60	24	9-2-9	(1)
			2	30	36	34	14	61	25	6-2-8	(6)
			7	29	38	33	12	63	25	6-2-7	(6)
		$\bar{x}$	6	30	36	34	15	63	22		
		σ	14	1	1	1	3	2	3		
					n = 13			n = 13			

TABLE 4. *Continued*

Stratigraphic unit	Lithofacies	Genetic interpretation	% gvl[2]	Grain size matrix[3] % Sd	% Si	% C	Clay mineral composition[4] % E	% I	% K+C	Sample number	
Tiskilwa Lower Unit	Dm(s)	Till and sediment flow deposits	4	35	41	24	6	72	22	W-9E-2	(1)
			5	36	43	21	6	71	23	W-9E-3	(1)
			6	33	36	31	15	73	12	WHJ-83-76	(1)
			5	33	36	31	7	76	17	WHJ-83-75	(1)
			6	30	39	31	6	76	18	WHJ-83-88	(6)
			16	31	52	17	11	77	12	WHJ-83-87	(6)
			8	35	39	26	10	72	18	9-84-23	(6)
			7	37	42	21	6	72	22	6-2-6	(6)
			2	32	43	25	6	71	23	6-2-5	(6)
			14	37	41	22	5	71	24	6-2-4	(6)
			11	45	38	17	7	73	20	6-2-3	(6)
		$\bar{x}$	8	35	41	24	8	73	19		
		σ	4	4	4	5	3	2	4		
				n = 11			n = 11				
	S	Fluvial deposits	0	98	2	0	30	47	24	6-2-2	(6)
			0	75	22	3	6	65	29	6-2-1	(6)
Peddicord Formation	Cm, Cℓ, STm	Lacustrine deposits	0	0	10	90	12	65	23	WHJ-83-48	(1)
			0	0	8	92	11	65	24	WHJ-83-47	(1)
			tr	1	6	93	25	65	10	W-9c-1	(1)
			tr	5	15	80	19	69	12	W-9d-1	(1)
			0	0	10	90	12	67	21	W-9d-2a	(1)
			0	1	86	13	15	60	25	W-9f-1	(1)
			0	0	28	72	13	66	21	W-9f-2	(1)
			0	0	24	76	14	66	20	W-9f-3	(1)
			tr	0	44	56	16	63	21	W-9f-4	(1)
		Range	0-tr	0-5,	6-86,	13-93	11-25,	60-69,	10-25		
				n = 9			n = 9				
Morton Loess	STm	Loess	0	1	85	15	37	48	15	W-9c-2	(1)
			tr	4	74	22	34	45	21	W-9d-3	(1)
Robein Silt	STm, Dm	Alluvial deposits	0	4	83	13	40	41	19	WHJ-83-49	(1)
			0	7	74	19	64	18	18	WHJ-83-50	(1)
			0	18	57	25	63	14	23	WHJ-83-51	(1)
			1	43	29	28	73	17	10	WHJ-83-52	(1)
			0	2	46	52	5	79	16	WHJ-83-53	(1)
			0	2	58	40	3	73	24	WHJ-83-54	(1)
			0	13	51	36	3	74	23	WHJ-83-55	(1)
			8	20	44	36	3	71	27	WHJ-83-56	(1)
			0	3	59	38	3	74	23	WHJ-83-57	(1)
			14	24	48	28	3	78	19	WHJ-83-58	(1)
			0	19	58	23	4	79	17	WHJ-83-59	(1)
			3	22	43	35	11	69	20	WHJ-83-60	(1)
			0	0	83	17	5	74	21	WHJ-83-61	(1)
			0	4	81	15	3	71	26	WHJ-83-62	(1)

Note: [1] Data are tabulated by lithofacies within each stratigraphic unit. Samples are from Pits 1 and 6. All lithofacies are not present or were not sampled at all sampling sites.

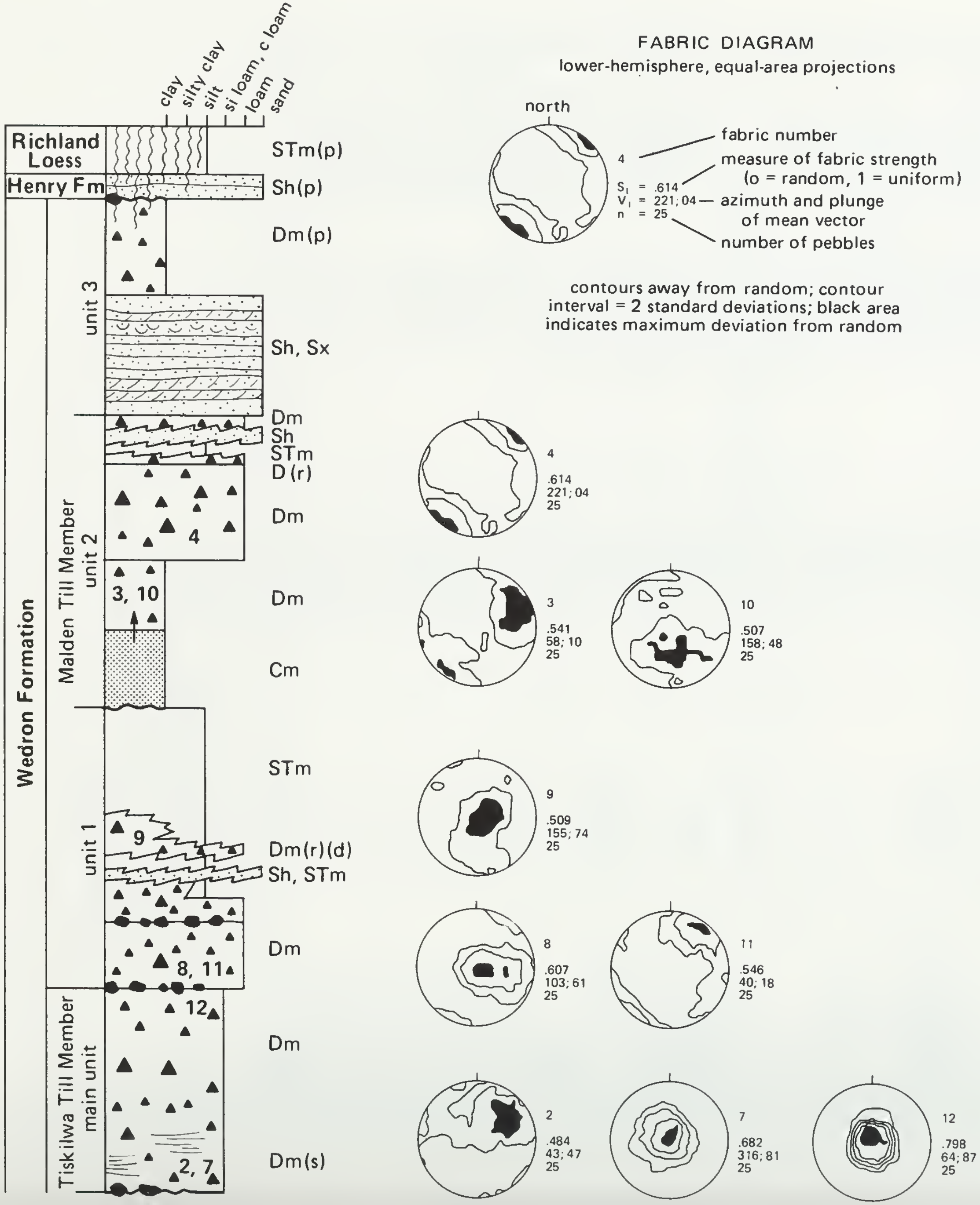
[2] Percent of whole sample

[3] Percent of < 2-mm fraction

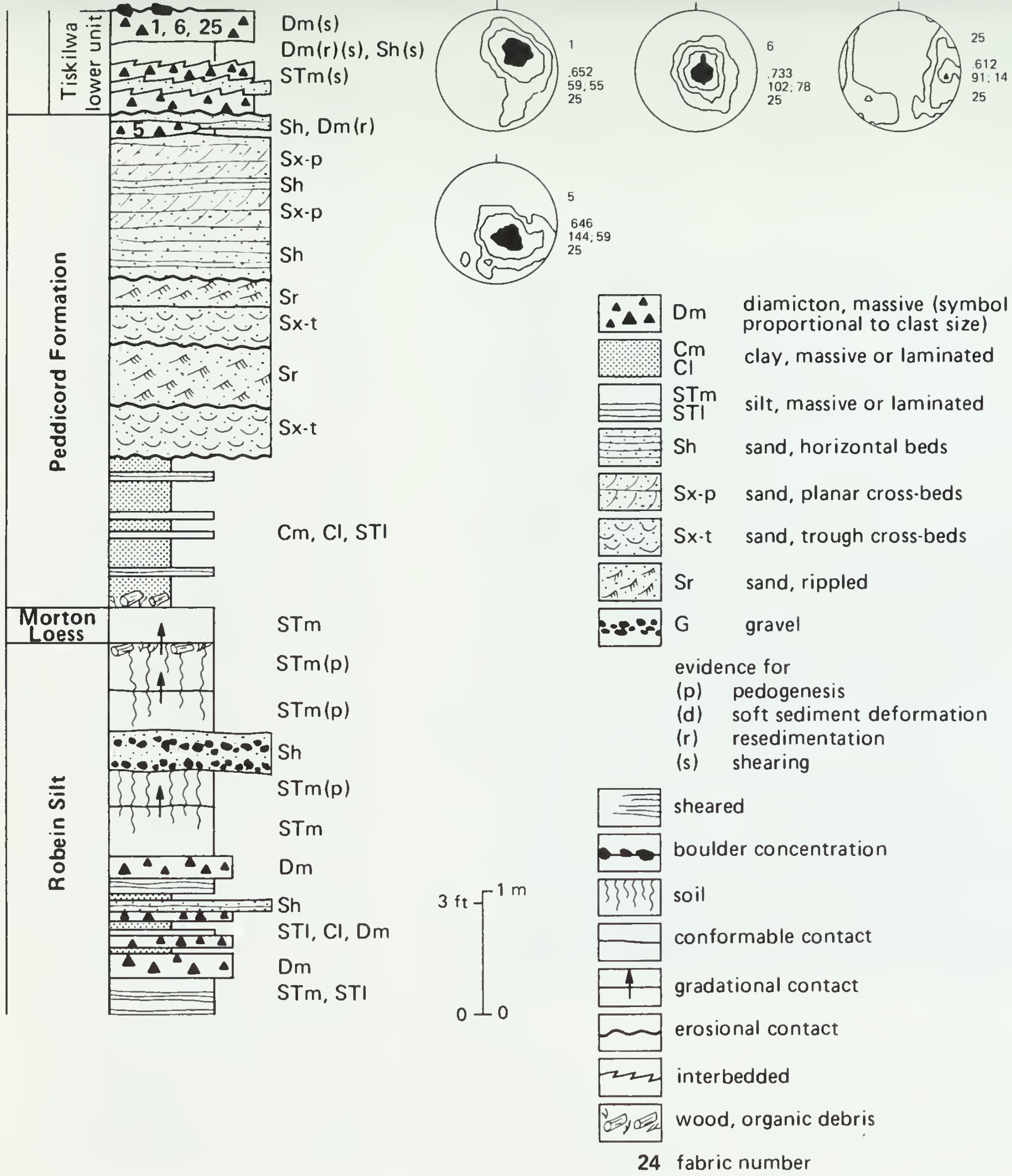
[4] Percent of < 2-µm fraction

[5] (1) Sample from Pit 1; (6) Sample from Pit 6

*Oxidized sample



STm	silt loam to silty clay loam, leached, part of Modern Soil, 0.2-1m.
Sh	sandy clay loam to clay loam, gravelly, leached, stone line locally at lower contact, discontinuous, 0-1m.
Dm	clay, pebbly, upper part leached, secondary $CaCO_3$ locally in lower part, discontinuous, 0-1.5m.
Sh	sandy loam to sandy clay loam, gravelly, locally leached in upper part, some units crossbedded, some beds coarsen upward, 0-2m.
Dm	loam to silt loam, pebbly, yellowish brown (10YR 5/4) grades to dark gray (10YR 4/1); upper part variable with zones of gravelly diamicton, pinkish diamicton and sorted sediment, calcareous, 1-2m.
Dm	silty clay, sparse pebble content, grades downward to silty clay (Cm), massive except locally laminated, calcareous, blocky, yellow brown (10YR 5/4) grading to dark gray brown (10YR 4/2), abrupt basal contact, 1-2m.
ST	silt loam to fine sand, well sorted, massive to weakly laminated, yellow (10YR 7/6), calcareous; coarse sand bed, locally pebbly at upper contact; locally contains lenticular diamicton beds; overlies interbedded sorted sediment and diamicton, locally deformed, 1-2m.
Dm	loam, pebbly, dark grayish brown (10YR 4/2), calcareous, few lenses and stringers of sorted sediment; boulder pavement at base and in unit, .5-1m.
Dm	clay loam, pebbly, brown to dark brown (7.5YR 4/2), calcareous, uniform, few thin stringers or inclusions of sorted sediment, one channel-shaped body of gravelly sand; carbonaceous silt in lower part along apparent shear plane; boulder pavements locally at contacts; upper part locally consists of interbedded diamicton and sorted sediment; 2-4m.



Dm	loam, pebbly, dark gray to dark grayish brown (10YR 4/1.5), locally uniform and up to 1m thick; commonly thin and interbedded with silt and sand beds; complex sediment relations; units deformed, 0.5-1.5m.
S	sand, fine to coarse, well sorted, beds 0.2-1m thick, horizontal and planar and trough cross-bedding, sands locally rippled; upper part contains silty interbeds and discontinuous bodies of diamicton; upper part locally deformed, 2-6m.
Cl, Cm	clay, brown (7.5YR 4/2), calcareous, interbedded with 1mm to 1cm gray (10YR 6/3) silt laminae; wood and organic debris common in lower part and margins of deposit; occurs in valley, thins toward margin, 0-2+m.
STm	silt loam, well sorted, brownish gray (10YR 5/2), dolomitic, discontinuous, 0-.15m, grades to
STm	silt loam, very dark gray (10YR 3/1), leached, common white silans, slightly platy, organic debris and wood locally abundant in upper part, A horizon of Farmdale Soil grades to fine loam, dark greenish gray (5BG 4/4), small subangular blocky structure, Bg horizon; 1.25m.
Sh	silty sand, and gravelly sand, stratified, fines upward, dark yellow brown (10YR 4/4) to dark grayish brown (2.5Y 4/2) abrupt contacts, 0.4m.
STm	silty clay loam, greenish gray (5GY 5/1), small subangular blocky structure, cutans, slickensides, Bg soil horizon, grades to silt loam, massive, calcareous at .35m. Lower part of unit interbedded silt, silty clays, thin sands and thin diamicton beds, base not exposed, 0-5m.

FIGURE 8. Composite section, lithofacies, descriptions, and pebble fabrics at Wedron Quarry.

Farmdale Soil is developed in the top of Robein Silt. The A horizon of the Farmdale is dark and cumulic, and contains abundant organic debris and wood. It overlies a weakly developed, gleyed, B horizon, and the soil is about 1.3 m thick. The soil probably is equivalent to what was described as Sangamon peat and muck in an earlier exposure in the northeastern part of Pit 1 (Willman and Payne, 1942).

MORTON LOESS

A thin, discontinuous dolomitic silt overlying leached Robein Silt has been observed relatively high on the valley sides and is usually no more than about 15 cm thick. It is gray to gray-brown and interpreted to be Morton Loess that was deposited on Farmdale Soil. In most cases it is missing in section and either was incorporated in the Farmdale Soil or eroded from the landscape.

PEDDICORD FORMATION

The Peddicord Formation was defined by Willman, Leonard, and Frye (1971) to include gray and pink silt that had accumulated in a lake confined to valleys of the Ticona drainage system. The Wedron Section (table 3) was designated the type section and the lake was interpreted to be of Farmdalian age. At Wedron, Willman and Frye (1970) reported up to 7.6 m of gray silt overlain by 6 m of pink, clayey silt in the unit. We have included an overlying sand unit in the Peddicord Formation; it is part of the proglacial sequence of well-sorted sediment.

Description

Willman and Frye (1970) described the lower gray unit, not currently exposed, as a massive blue-gray to tan silt that contains some clay and fine sand. They reported a clay mineral analysis of one sample as 12% expandable clay minerals, 38% illite, and 50% kaolinite plus chlorite, and a date of 26,800 ± 700 (W-871) RCYBP on detrital wood.

Only the upper part of the pink unit (about 2 m) is exposed. It is a pinkish gray to red-brown calcareous clay that is massive to faintly laminated. Light gray silt beds 1 mm to 1 cm thick occur at approximately 20-cm intervals. Some clay beds contain over 90% clay (table 4). The basal part contains abundant wood fragments and lenses and thin beds of organic debris. Adjacent to near-vertical valley sides, the clay beds interfinger with organic debris layers and sandy colluvium derived from St. Peter Sandstone. The pink clay contains about 65% illite in the clay fraction (table 4). Radiocarbon dates on detrital wood from the pink unit are 24,370 ± 310 (ISGS 863); 24,900 ± 200 (ISGS 862); and 24,000 ± 700 (W-79).

A thick sequence of generally well-sorted coarse-to-fine sand containing small amounts of gravel abruptly overlies the pink clay. The contact is erosional. Individual beds are generally from 0.2 to 1.0 m thick. They are predominantly medium-to-coarse sand beds with planar and trough cross-bedding. Fine sand and silt in thin horizontal beds and ripple-drift cross-laminations predominate in the upper part of the sand sequence (fig. 8). Locally, pebble-size clasts of the underlying silty clay are present in the toe of crossbeds (fig. 9). The dip direction of the foresets of cross-beds generally is south and southwest. The sand appears to be pervasive across the sandstone surface. Maximum total thickness of the sand is more than 6 m. Lenticular beds of

FIGURE 9. Pebble-sized clasts of silty clay in cross-bedded sand of Peddicord Formation, Wedron Quarry, Pit 6. Trowel handle is 10 cm long.

diamicton up to 0.7 m thick are present locally in the upper part of the sand underlying the gray diamicton (fig. 10).

Interpretation.

We interpret the overall succession to be proglacial in origin; the local depositional environment changed from alluvial to lacustrine to glaciofluvial as the Woodfordian ice margin advanced in northern Illinois. The lower gray and pink units accumulated in a dammed drainage system. The color and clay mineral composition of the pink clay are similar to those of the Tiskilwa Till Member, suggesting that the Tiskilwa ice margin was nearby and that the drainage system was dammed by the Tiskilwa ice margin or by outwash from that ice sheet. The fine-grained character of the deposit suggests that the dam

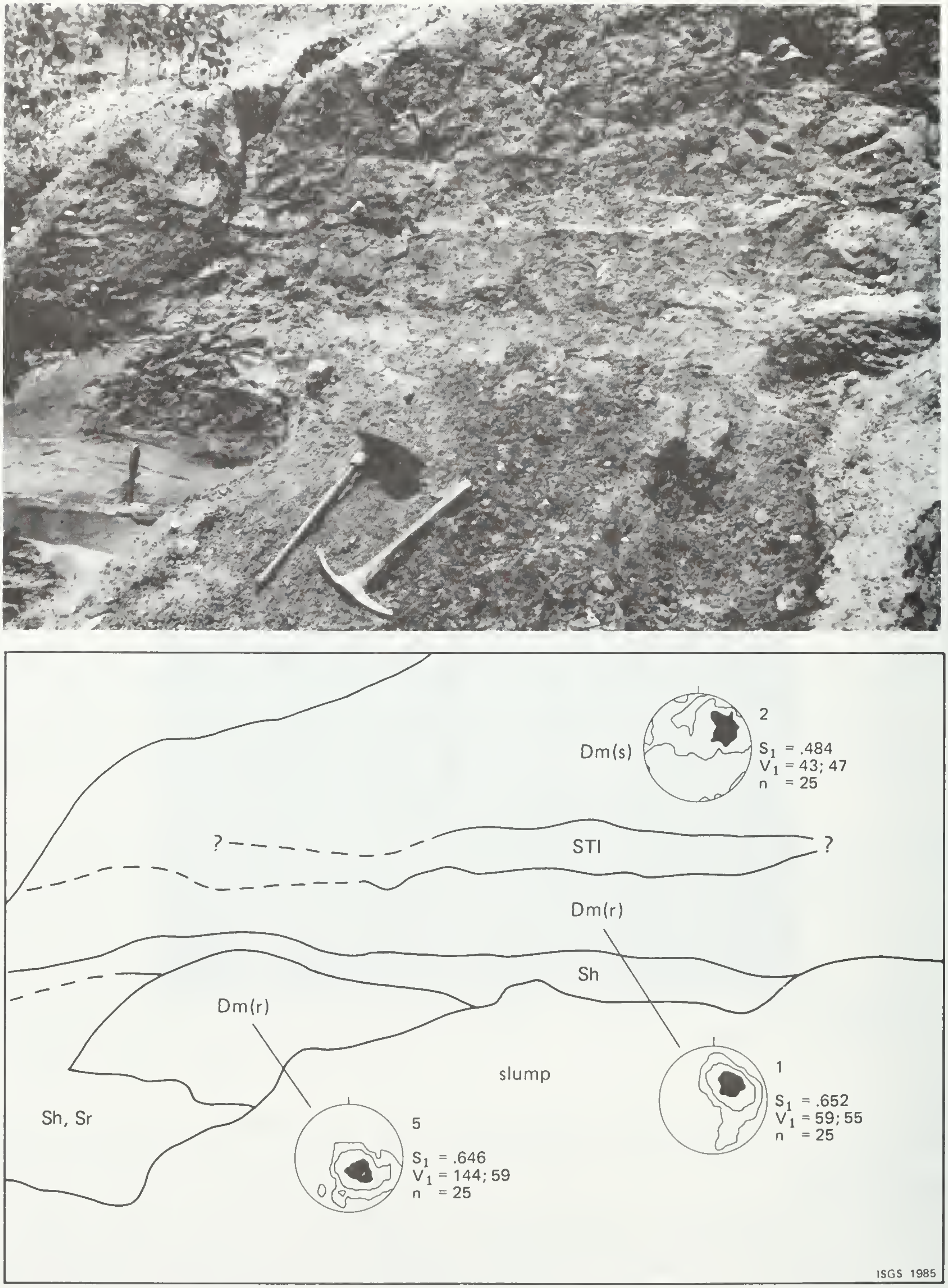


FIGURE 10. Red-gray diamicton (Dm(s)) of main unit of Tiskilwa Till Member overlying fine-grained sediment (STI) and gray diamicton (Dm(r)) of lower unit. Note lenticular bed diamicton (Dm(r)) in underlying sand (Sh, Sr) of Peddicord Formation, Wedron Quarry, Pit 6. Pick is 44 cm long.

was located some distance downstream from Wedron. Lake Peddicord inundated the Farmdale Soil that had formed in the valleys, and wood and organic debris were washed into the lake from valley sides and adjacent uplands.

The color and clay mineral composition of the lower lacustrine unit differ from those of the upper unit, and the one available date suggests that the lower unit may be as much as 1000 years older. Both units probably were deposited during a single lake event (Willman and Frye, 1970, report a conformable contact), but at a section 30 km to the east near Morris (Morris North Section), the pink unit appears to be confined to a valley cut into the lower gray unit (Willman, Leonard, and Frye, 1971) and the lake history may be more complex. The change in color and composition is interpreted as reflecting a change in sediment source. The gray deposits probably were derived primarily from sediment and bedrock within the drainage basin and the overlying pink clay from an influx of glacially-derived sediment. The lake existed in latest Farmdalian and earliest Woodfordian.

The depositional environment changed abruptly, probably as a result of drainage of the lake and development of drainage to the south and southwest. The lake sediments were eroded locally, and the overlying sand was deposited in the former valley and as a broad sheet across the adjacent bedrock upland.

We interpret the upper unit to be proglacial fluvial sand that was deposited as part of an outwash plain or possibly a broad valley train. The dominance of sand and the sparse gravel content indicate either a distal depositional position relative to the ice margin or a system that had minimal coarse debris supplied to it; the second interpretation is supported by the lack of an upward coarsening grain size toward the contact with overlying glacial diamicton and the presence of gravel-size clay pebbles, which indicates adequate competence to transport gravel-size particles. A significant portion of the sand may have been derived locally from St. Peter Sandstone. The channel pattern was braided with transverse or linguoid bars, as indicated by the planar cross-beds, and interbar channels that were filled with trough cross-bedded sands. Planar beds probably reflect flood flows and submergence of the bars. The system probably had a relatively small gradient and the deposit appears similar to the Platte-type braided river facies described by Miall (1977).

The discontinuous diamicton layers in the upper part of the sand are interpreted to be sediment flow deposits. They occur as discrete bodies and probably are the result of sediment flows from the ice margin into the proglacial fluvial environment.

Discussion

Our interpretations of depositional environments are in agreement with prior interpretations at Wedron; however, our stratigraphic interpretations differ, particularly in respect to the age and origin of Lake Peddicord. Previous interpretations related the lacustrine deposits either to Lake Kickapoo, interpreted to postdate the initial Woodfordian ice margin advance and therefore to be younger (Willman and Payne, 1942), or to Lake Peddicord, thought to predate the earliest Woodfordian glaciation and inferred to be Farmdalian and older in age (Willman, Leonard, and Frye, 1971).

Lake Kickapoo was interpreted to have formed in front of the retreating ice margin in the Ticona Valley after the Shelbyville Moraines dammed the drainage system at Peoria, Illinois. Deposits in the lake were then buried by outwash of the succeeding Bloomington advance (Willman and Payne, 1942). However, Leighton and Willman (1953) and Leonard and Frye (1960) later observed till overlying the lake deposits at Wedron that was interpreted to be Shelbyville drift; therefore, the lake deposits had to be older. They were called Farmdale Silt. Radiocarbon dates confirmed a Farmdalian age (Leonard and Frye, 1960). The name Farmdale subsequently was replaced by Robein (table 3) to correct a duplication in nomenclature (Willman and Frye, 1970).

The Peddicord Formation (Willman, Leonard, and Frye, 1971) was defined in order to remove these distinctive lacustrine deposits from the Robein Silt, a unit composed primarily of accretionary silt and organic debris that accumulated in low, poorly drained areas of the pre-Woodfordian landscape. The Peddicord was based on the succession at Wedron and the Morris North Section, 30 km to the east. The Peddicord was considered to be older than the Lee Center Till Member at Wedron and the Robein Silt at Morris North, and to be younger than the Sangamon Soil (as described in Willman and Payne, 1942) at Wedron. Willman, Leonard, and Frye (1971) suggested that Lake Peddicord might have formed in response to damming of the Ticona Valley by Altonian drift to the west.

Our stratigraphic interpretations differ from these earlier interpretations in the following ways:

> The soil below the Peddicord is considered to be Farmdale Soil, not Sangamon Soil. The correlation is based on the character of the soil, its stratigraphic position, and our current understanding of relationships between these two soils and their history.
>
> The unit called Robein Silt at Morris North is probably Morton Loess. It is calcareous and differs from the overlying Morton only in containing organic streaks and mollusk shells. Dolomitic and carbonaceous late Wisconsinan loess is known elsewhere in Illinois (McKay, 1979).
>
> The Woodfordian-Farmdalian boundary is now considered to be approximately 25,000 B.P. rather than 22,000 B.P. on the basis of new radiocarbon dates at the type section of the Farmdalian Substage (Follmer et al., 1979).
>
> The material called Lee Center is interpreted to be the result of the Tiskilwa glacial event rather than an earlier event.
>
> Work in north-central Illinois suggests that drift previously considered to be Altonian (Winnebago Formation) is Illinoian (J. P. Kempton, personal communication). Thus, Lake Peddicord probably is not the result of an Altonian glacial event.

We view the succession as a proglacial sequence deposited in response to an advancing Tiskilwa ice margin in northern Illinois. Further regional studies are necessary to determine stratigraphic relationships between the Peddicord Formation and other deposits attributed to Lake Kickapoo. It appears likely that most or all may be related to a single lacustrine event.

TISKILWA TILL MEMBER

The lower two distinct diamicton units at Wedron are included in the Tiskilwa Till Member. Willman and Frye (1970) interpreted the lower of the two units to be Atkinson Drift and correlated it to the Lee Center Till Member (table 3). We reject the latter correlation because the Lee Center is Illinoian; we include the lower diamicton unit with the Tiskilwa and interpret it as a basal facies.

Description

Lower unit. The lower 1 to 2 m of the Tiskilwa Till Member (fig. 8) is grayer than the main part of the unit and is texturally more variable. The matrix of 11 diamicton samples analyzed averaged 35% sand, 41% silt, and 24% clay. Standard deviations were 4%, 4%, and 5%, respectively (table 4). The < 2-μm fraction of the 11 samples averaged 73% illite (2% standard deviation). The lower unit contains discontinuous beds of massive or laminated silt and fine sand (fig. 10). Massive or indistinctly laminated silt and fine sand beds occur locally at the contact with the underlying sand and the contact is generally erosional (fig. 11). Thin beds of diamicton and sand at the base of the unit commonly show evidence of shear deformation (fig. 12). Shear attenuation of the underlying sand beds (fig. 13) and recumbently folded silt interbeds have been observed (fig. 14). Pebbles (predominantly blades and plates) having steeply dipping preferred orientations (fig. 8, fabrics 1 and 6) are present. At Pit 6 a discontinuous boulder pavement is present at the contact between the lower unit and the main unit of the Tiskilwa. Azimuths of the striations range from 70 to 80°.

Main unit. The massive, overlying red-gray (generally 7.5YR 4/2) diamicton (Dm, Dm(s)) is characterized by uniform texture and clay mineral composition. The matrix in 13 samples analyzed averaged 30% sand, 36% silt, and 34% clay; standard deviations were 1%, 1%, and 1%, respectively (table 4). The

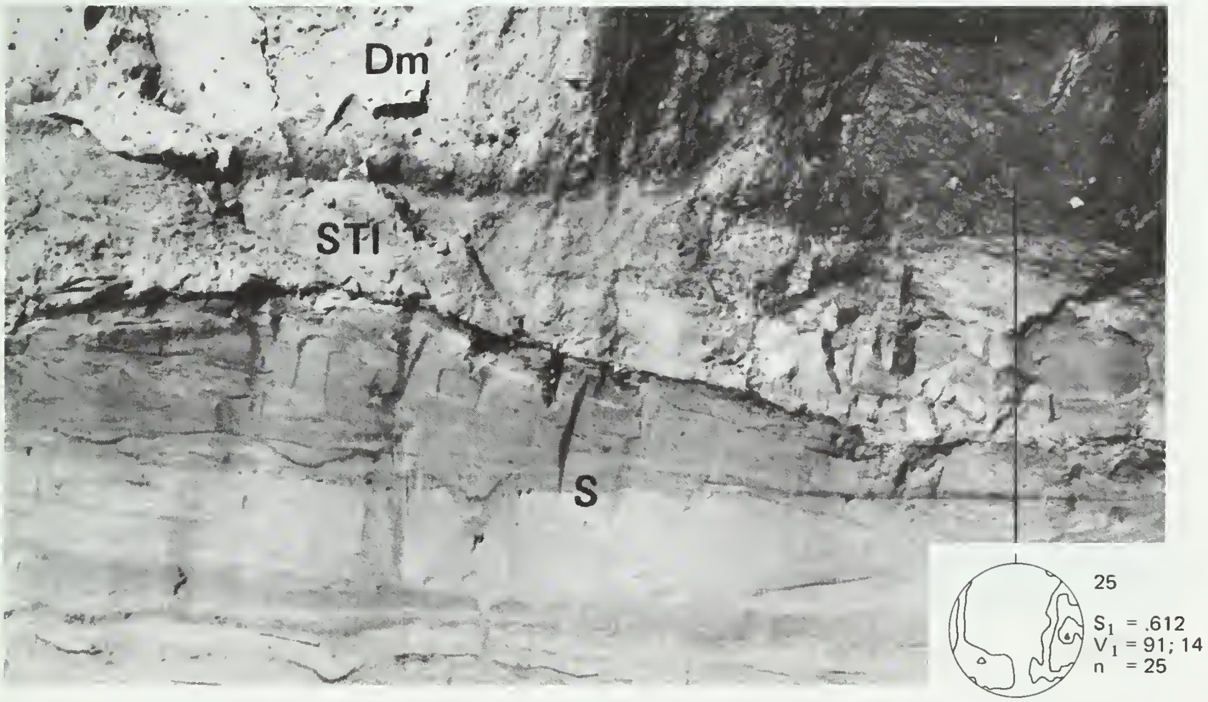


FIGURE 11. Deformed sand of Peddicord Formation beneath erosional contact with fine-grained sediment (STl) at base of gray diamicton (Dm) of lower unit of Tiskilwa Till Member, Wedron Quarry, Pit 6. Knife handle is 8.5 cm long.

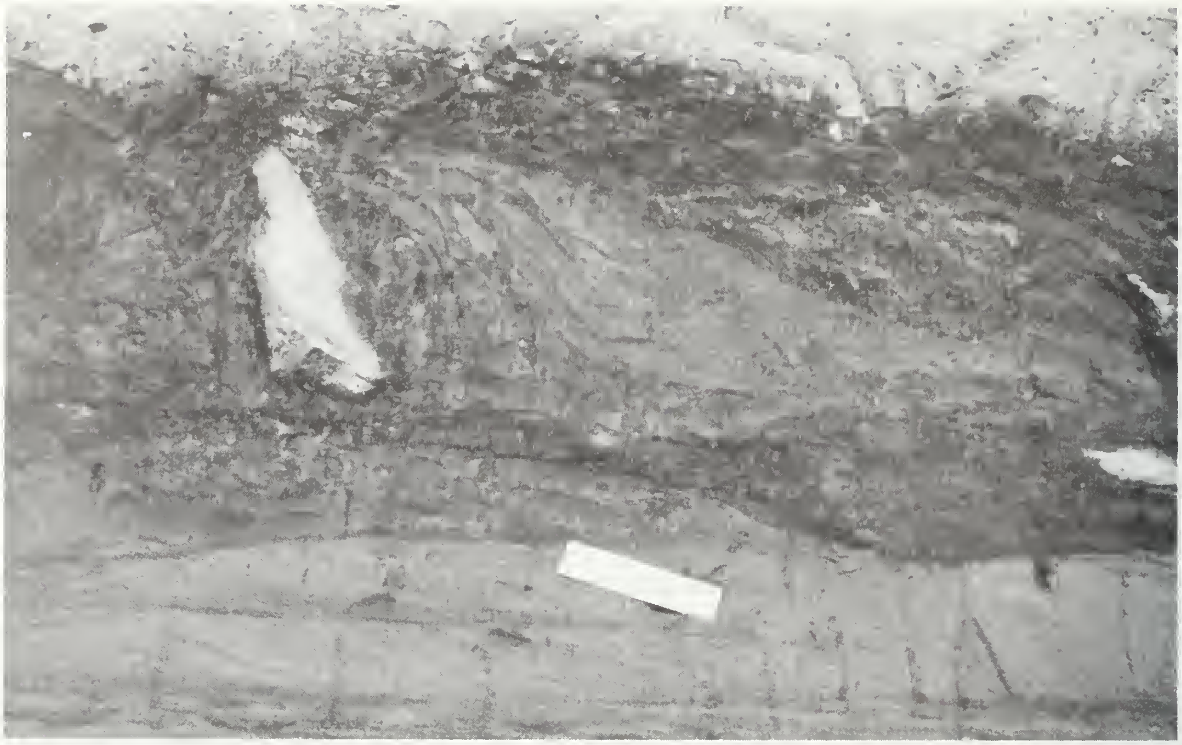


FIGURE 12. Deformed, interbedded diamicton and sand at base of lower unit of Tiskilwa Till Member, Wedron Quarry, Pit 6. Sense of shear is approximately parallel to direction of regional ice flow (right to left in photo). Scale is 15 cm long.

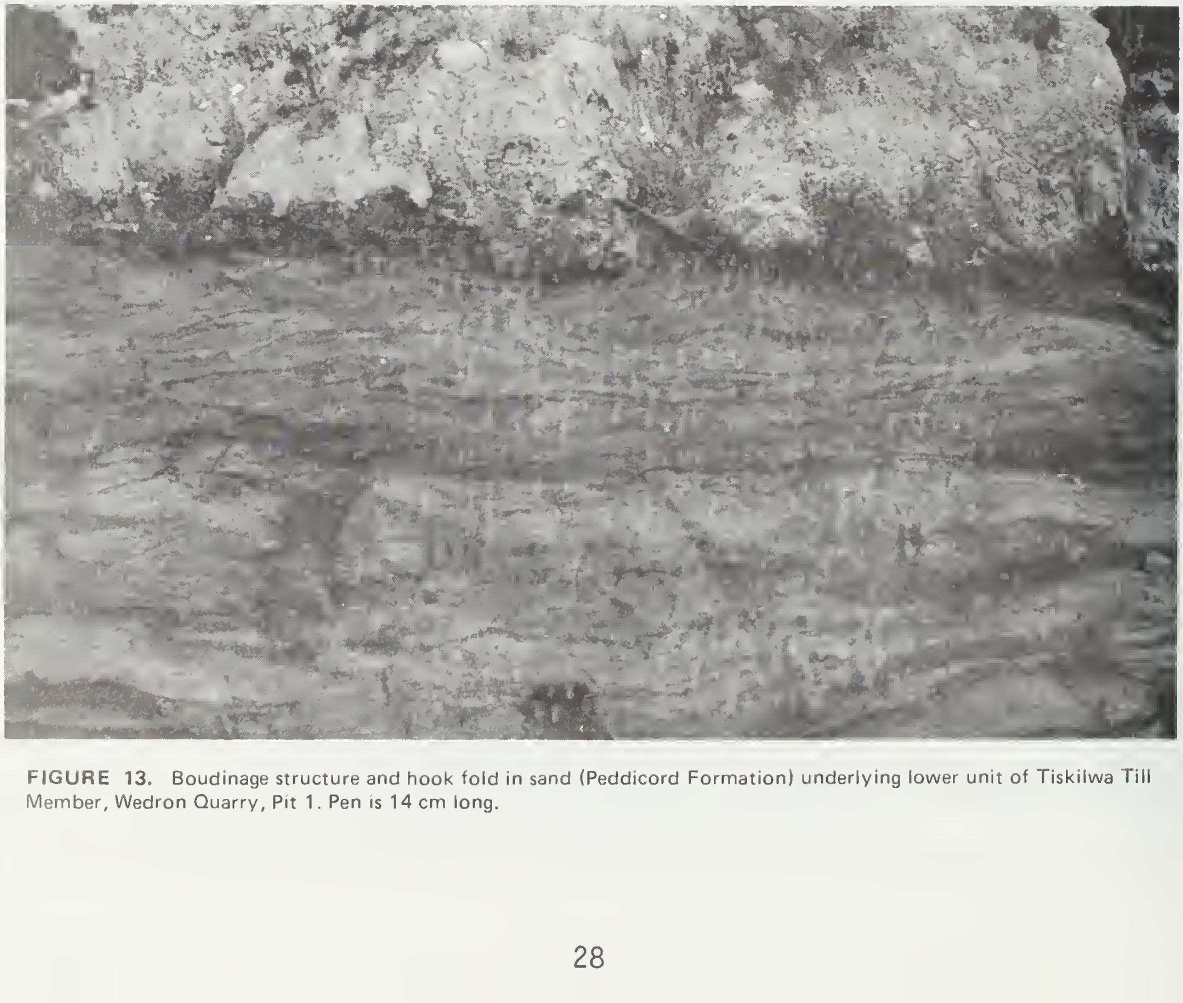


FIGURE 13. Boudinage structure and hook fold in sand (Peddicord Formation) underlying lower unit of Tiskilwa Till Member, Wedron Quarry, Pit 1. Pen is 14 cm long.

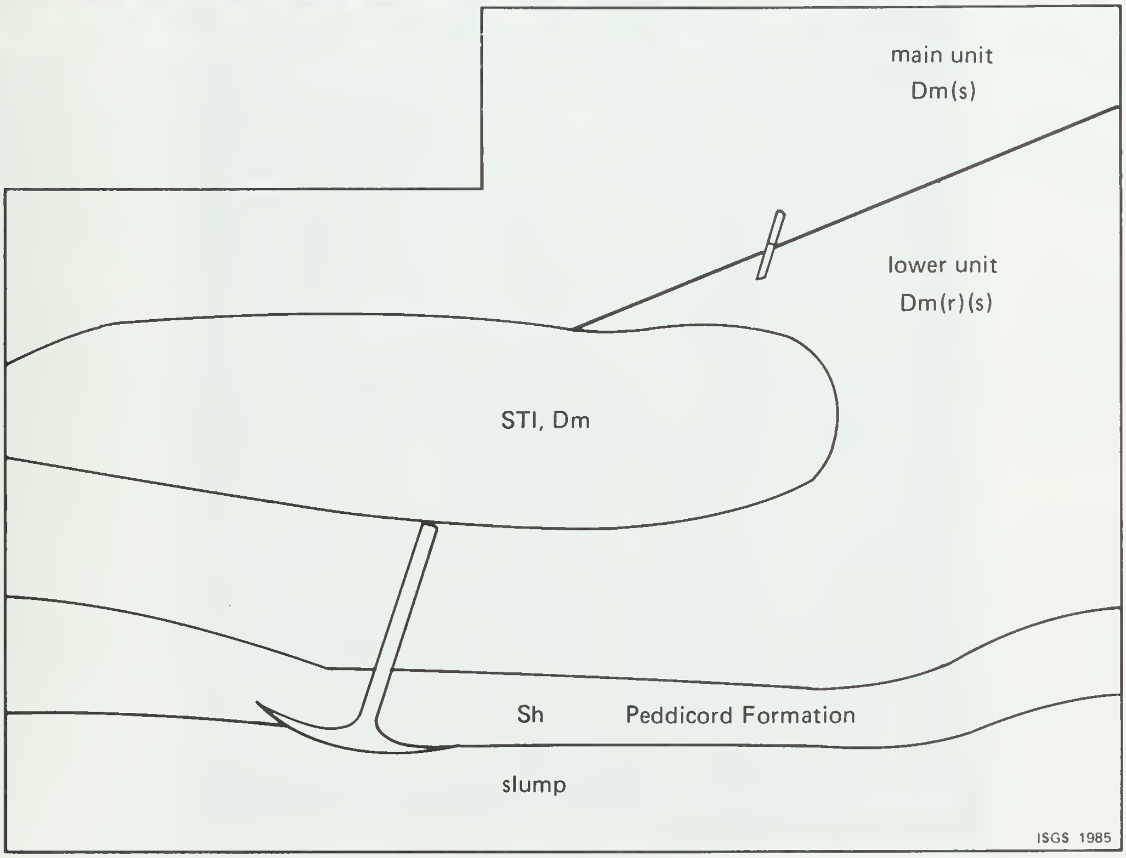


FIGURE 14. Folded silt and diamicton (STI, Dm) in lower unit of Tiskilwa Till Member (Dm(r)(s)), Wedron Quarry, Pit 6. Thick, black line indicates silt displaced along shear plane at base of main unit of Tiskilwa Till Member (Dm(s)). Pick is 44 cm long.

< 2-µm fraction of the 13 samples analyzed averaged 63% illite (2% standard deviation). Small lenses of sorted sediment (sand and fine gravel) and larger channel-shaped bodies of gravelly sand are present but rare. Locally, the upper part of the diamicton is interbedded with sand and overlain by sand containing pods of diamicton (fig. 15). A layer of organic silt (Robein Silt?) occurs along a shear plane near the base of the diamicton in Pit 1. The red-gray diamicton is generally 2 to 4 m thick. Diagrams of pebble fabric show a near-vertical orientation of blade- and disc-shaped pebbles (fig. 8).

Interpretation

We interpret the red-gray diamicton in the Tiskilwa Till Member to be basal till, probably deposited by lodgement. A basal origin and deposition beneath active ice is also inferred for part of the grayer, lithologically variable lower unit.

FIGURE 15. Sand containing lenticular pods of diamicton, overlying diamicton containing beds of sand, at top of main unit of Tiskilwa Till Member, Wedron Quarry, Pit 1. Knife handle is 8.5 cm long.

Lower unit. The different color, texture, and clay mineral composition of the lower unit is attributed to local incorporation of Pennsylvanian bedrock or previously deposited drift, whereas the character of the overlying red-gray diamicton is interpreted as reflecting incorporation of material derived from distant source areas (Wickham and Johnson, 1981). The local bedrock (Paleozoic shale) and sediment derived from the Lake Michigan Basin generally contain a large percentage of illite in the < 2-μm fraction and presumably the larger percentage of illite in the lower part of the Tiskilwa Till Member reflects incorporation of this material.

Pebble fabrics from both the lower gray diamicton and the overlying red-gray diamicton indicate steeply-dipping preferred orientations of blade- and disc-shaped pebbles (fabrics 1, 6, 7, and 12, fig. 8). Several researchers, including Holmes (1941), Harrison (1957), Lindsay (1970), Kruger (1970), Drake (1974), and Mills (1977), have attempted to relate pebble shape to fabric. Some evidence indicates that pebble shape and size affect orientation, but the nature of that relationship is not clear.

Vertical or near-vertical pebble orientations have been reported in diamictons of various origins. Griggs and Kuhm (1969) and Gibbard (1980) described waterlain diamicton with near-vertical orientation of the long axes of pebbles. Lawson (1979), Boulton (1971), and Boulton and Paul (1976) described vertical fabrics in modern subaerial sediment flows and fluted deposits. Domack (1982) reported vertical or near-horizontal preferred orientation of pebbles in diamicton that he interpreted to be basal till deposited by lodgement. However, his fabric data were limited and genesis was inferred from other properties. With the exception of Domack (1982), researchers have not described tills having preferred pebble orientations with steep dips such as in the red-gray diamicton and the lower gray unit. Although the relationship of the near-vertical fabrics to genetic process is unclear (see following discussion section), the statistically significant fabrics are similar in both units, suggesting that both were the result of a common process of deposition or subsequent deformation.

Fabric 25 (figs. 8 and 11), based on the azimuth and plunge of the long axes of prolate- and blade-shaped pebbles in the lower gray diamicton, indicates a preferred orientation of pebbles parallel to regional ice flow direction, as inferred from the trend of the Bloomington Morainic System. Average pebble plunge is 14° up-ice. Other features indicating that some of the gray lower diamicton is till are uniform texture and clay mineral composition (table 4) and generally massive structure.

A significant portion of the lower Tiskilwa has been deposited by other processes. The beds of sorted fine-grained sediment (figs. 10 and 11) were either deposited by meltwater or sediment flow in cavities beneath the ice, or deposited proglacially. These deposits occur laterally adjacent to and closely associated with basal till, and the sediment flow deposits are similar in color and clay mineral composition to the till. These relationships and the lack of sediment flow beds similar in character to the main Tiskilwa suggest that much of the resedimentation occurred in the subglacial environment. Deposition probably took place just back of the ice margin in shallow subglacial drainageways or in crevasse-related cavities. With further advance of the ice margin, basal conditions changed and the lower unit deposits were deformed. Shear structures, such as deformed sand and diamicton interbeds and steeply dipping boulders (fig. 12), boudinage structures and hook folds (fig. 13), and recumbently folded silt and displaced sediment along shear planes (fig. 14) are interpreted as evidence of stress applied by glacial movement.

In some places the upper contact of the lower unit is interpreted to be an erosion surface that formed in the subglacial environment, probably as a result of a change in the basal ice regime from depositional to erosional. Erosion is indicated by the truncation of beds in the lower unit, the discontinuous striated boulder pavement, and the abrupt contact. The succession of deposits above and below the erosional contact is interpreted as an example of "uncomformable facies superimposition" (Eyles and others, 1982).

Main unit. The main unit of the Tiskilwa is interpreted to be basal till, probably of lodgement origin. Evidence for this interpretation is the extremely uniform texture (table 4) and color, massive structure, and scarcity of lenses and layers of sorted sediment. One relatively large, channel-shaped body of outwash within the till is interpreted to have been deposited in a subglacial drainageway.

The upper part of the main unit, consisting of interbedded sand and diamicton, and sand containing pods of diamicton (fig. 15), is interpreted to be sediment flow and fluvial deposits that probably accumulated in the supraglacial or ice-marginal environment. These deposits suggest a retreat of the ice margin, but (as discussed later) their stratigraphic position with respect to the lower unit of the Malden is unclear.

The entire vertical succession of gray, lithologically variable diamicton, massive, uniform red-gray diamicton, and interbedded diamicton and sorted sediment is interpreted as representing basal till deposition; subglacial resedimentation, deformation, and erosion; further basal till deposition (the main unit of the Tiskilwa); and subsequent ice-marginal resedimentation during a single glacial event.

Discussion

Nomenclature of lower unit. The lower, gray diamicton complex has previously been interpreted as the Lee Center Till Member and related to the Shelbyville or Atkinson Moraines. The name Lee Center is inappropriate at Wedron because the Lee Center is Illinoian in the type area and thus the correlation is in error. The unit is distinct and generally recognizable in the field, as at Wedron. Similar zones occur discontinuously at the base of the Tiskilwa Till Member elsewhere in northern Illinois (Wickham and Johnson, 1981; Wickham, Johnson, and Glass, in preparation), and a new unit could be defined for these materials. This does not seem necessary, however, because the unit can be treated as a basal facies of the Tiskilwa Till Member. It is closely related to the Tiskilwa and is not known to occur as a surface mappable unit west of the Bloomington Morainic System.

Glacial history of lower unit. We interpret the lower unit to be related to the same ice event that deposited the overlying Tiskilwa Till. A more traditional interpretation is to relate it to an earlier, separate event because it has a different color and composition, contains both basal till and diamictons of sediment flow origin, and has an abrupt, upper erosional contact marked locally by a boulder pavement.

In addition to the evidence discussed previously, characteristics of the proglacial lacustrine deposits support our interpretation. The pink clay in the Peddicord Formation has a color and clay mineral composition similar to that of the main unit of the Tiskilwa Till Member. If there had been an earlier glacial event, the subjacent proglacial lake deposits should have the color and composition of the diamicton related to that event. Because the lake deposits are not similar in color and composition to those of the lower unit of the Tiskilwa, it is inferred that most of the debris in the ice sheet had a composition similar to that of the main Tiskilwa unit, and that the basal debris zone of different composition was thin and did not significantly influence the character of the lake deposits.

Origin of fabric. The origin of the steeply-dipping orientation of disc- and blade-shaped (mostly shale) pebbles in the Tiskilwa (fabrics 1, 6, 7, and 12, fig. 8) is problematic. We used these shapes in our initial work primarily because shale fragments are common in the diamicton; pebbles of these shapes are much more abundant than are prolate pebbles. Of the few prolates measured, five had plunges more than 45° but five had plunges less than 30°. Fabric 25, based on the azimuth and plunge of the long axes of prolate- and blade-shaped pebbles in the lower Tiskilwa, had a typical "till" fabric (mean vector dip of 14°); fabrics measured in Malden unit 1 (fabric 10) and Malden unit 2 (fabric 4), utilizing mainly the orientation of planes defined by disc- and blade-shaped pebbles, also had more typical "till" fabrics (mean vector dips of 18° and 4°, respectively). From these observations, it is not clear whether the steeply dipping pebbles are primarily a reflection of the pebble shapes and orientations measured or other controlling factors.

It is difficult, conceptually, to visualize basal till deposition with pebbles dipping 40 to 80°. It also is difficult to understand why the dip direction or strike of these pebbles is not more consistent, since they should be responding to glacier-induced stress during transport and deposition. The fact that several fabrics indicate steeply dipping pebbles suggests that the observations are valid. If the fabric is depositional in origin, it would appear that the basal debris zone must have been extremely debris-rich (very little ice) and that either intense longitudinal or transverse compression influenced basal deposition. Particles apparently can be lodged or melted out with little modification of their in-ice orientation under these conditions.

The occurrence of deformational features in the Tiskilwa suggests that the fabric might be the result of deformation after deposition. One relatively large syncline in the lower Tiskilwa has rather steep limbs (about 50°) and plunges in a general up-ice direction. The structure suggests that locally the section has undergone transverse compression; the pebble orientations might be a response to such stress. Other structural features, however, are small or do not have steeply dipping structural attributes. In addition, the sand unit below the Tiskilwa is not highly deformed, and major lithologic contacts are planar and generally undeformed. Thus, the observed fabric is probably depositional in origin, but may have been modified somewhat by subsequent deformation. Further study clearly is warranted.

MALDEN TILL MEMBER

Gray diamictons and associated sorted deposits that overlie the red-gray Tiskilwa Till are included in the Malden Till Member. The lower unit of this succession may have been included in the Tiskilwa Till Member by Willman and

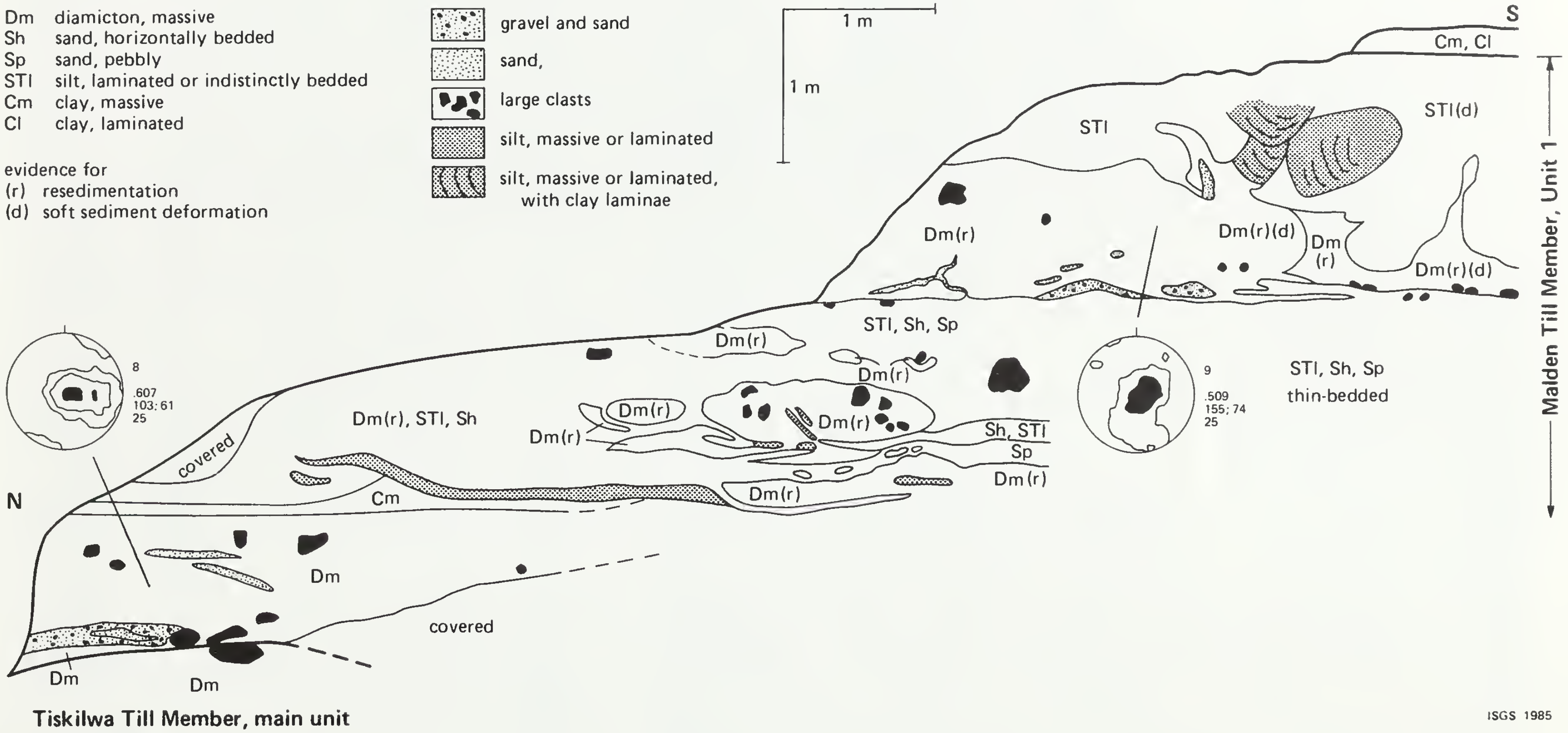


FIGURE 16. Sketch showing complex relationships, unit 1, Malden Till Member, Wedron Quarry, Pit 1.

Frye (1970). They report an indistinct boulder pavement within the Tiskilwa Till (table 3), which may be the same one that occurs where we have placed the contact. They do not refer to a color change, however, and color changes were stressed in their unit definitions. Willman and Frye also related four Malden "drifts" at Wedron to end moraines to the west. We have not utilized the morphostatigraphic classification because we are unsure of correlations to end moraines. We have recognized three subdivisions of the Malden, however, and will refer to them informally as unit 1, unit 2, and unit 3, from the base upward.

Description

Malden unit 1. A discontinuous line of boulders with striations having azimuths most commonly from 70 to 80° is present at the contact between red-gray massive diamicton (Tiskilwa Till Member) and overlying grayer (10YR 4/2) diamicton (unit 1) (Dm, fig. 8). Locally, the azimuth of striae is more northerly (20 to 50°) and is consistent with the orientation of pebbles in the overlying diamicton (fabric 11, fig. 8). Although there is a distinct color change at the contact, the diamicton of unit 1 is less gray than diamicton of unit 2 and, where oxidized, the color is not greatly different from that of underlying Tiskilwa diamicton. Generally the lower 0.2 to 1.0 m of the grayer diamicton is massive, with few lenses, layers, and stringers of sorted sediment. The matrix of the diamicton is coarser than that of the Tiskilwa and is fairly uniform; its sand content ranged from 29 to 44%, silt content from 30 to 45%, and clay content from 15 to 29% (table 4). The < 2-µm fraction ranged from 61 to 72% illite (6 samples analyzed). Fabric diagram 8 shows a steeply dipping (61°) preferred orientation of pebbles in the gray massive diamicton (fig. 16). A discontinuous boulder pavement occurs locally within the lower meter of massive diamicton in Pit 6.

The generally massive diamicton is overlain by a variable unit of interbedded diamicton and sorted sediment (Dm(r),STm,Sh) in which sediment relationships are complex. Diamicton is present as discontinuous beds, lenticular bodies, and inclusions in crudely bedded, variably sorted sand, silt and gravel (fig. 16). Color, grain size, and clay mineral composition in these diamicton bodies are somewhat variable but generally are similar to those in either the underlying massive gray diamicton or the red-gray Tiskilwa diamicton. Fabric diagram 9 (fig. 16) shows the lack of a preferred orientation of pebbles in an upper diamicton lens. A massive to indistinctly laminated silt (STm), 0.5 to 2 m thick, is present above these deposits in all sections at Wedron. Diapirs of diamicton locally penetrate the silt (fig. 16). The silt is overlain by silty clay with a planar or slightly wavy contact that is locally erosional.

Malden unit 2. The silty clay (Cm) at the base of unit 2 is 0.5 to 1.5 m thick, and predominantly massive; indistinct laminations are present and are more apparent in the lower part. Pebbles are rare. Four samples analyzed contained 0 to 4% sand, 21 to 47% silt, and 53 to 76% clay (table 4). The < 2-µm fraction of two unoxidized samples contained 73% and 77% illite. The silty clay grades upward to diamicton (Dm) with more abundant pebbles and a larger percentage of sand. Eight samples analyzed contained 3 to 13% sand, 29 to 40% silt, and 47 to 68% clay. Illite in the < 2-µm fraction of 7 unoxidized samples ranged from 69 to 77%. Diagrams of pebble fabrics 3 and 10 (fig. 8) show a weak to non-preferred orientation of pebbles in the silty clay diamicton.

The silty clay diamicton is overlain by about 2 m of loam diamicton (Dm) that is texturally uniform and massive but has a few thin lenses and stringers of sorted sediment. The mean percentages of sand, silt, and clay in 14 diamicton samples analyzed were 33%, 46%, and 21%, respectively; standard deviations were 3%, 3%, and 3%. The < 2-µm fraction contained 73% illite in 12 samples analyzed, and the standard deviation was 4%. Fabric diagram 4 (fig. 8) shows a preferential orientation of pebbles with an average azimuth of 221° and pebble dip of 4°. Two bullet-shaped boulders in the diamicton have striae parallel to the long axis of the boulder and azimuths of 70° and 85°.

In the southeast wall of Pit 1, large bodies of red-gray diamicton (Tiskilwa) and a clayey diamicton occur within the upper part of unit 2. Structural relationships are complex and the included bodies have a near vertical orientation.

Locally, thin beds of diamicton (D(r)) with variable texture, color, and clay mineral composition are present above the more massive gray diamicton. These upper diamicton layers are interbedded with sorted sand and silt. In four samples of diamicton (table 4), sand ranged from 4 to 38%, silt from 38 to 68%, and clay from 4 to 34%. Illite ranged from 64 to 77% in the clay fraction of these oxidized and unoxidized samples. In other areas the diamicton grades upward into gravelly diamicton that locally is redder than it is elsewhere.

Malden unit 3. A gravelly sand (Sh,Sx) unit overlies Malden unit 2 and locally is overlain by fine-grained diamicton. The sand unit is stratified and cross-bedded and generally contains multiple coarsening upward sequences. Local lenticular bodies of pea gravel are present at the base or within the unit. The unit is best exposed in Pit 6 where it is up to 2 m thick. The unit is truncated by the surface valley slope.

The overlying diamicton (Dm) has not been studied from a sedimentological standpoint. It is discontinuous in section and the maximum thickness observed was 1.5 m. It contains few pebbles and on the basis of five samples analyzed has a clay texture (table 4). The < 2-µm fraction of these oxidized samples averaged 77% illite. Secondary $CaCO_3$ is locally abundant as fracture fillings and concretions. The upper surface of the diamicton has been truncated and locally is marked by a thin, pebbly loam lag concentration. The diamicton and subjacent sand and gravel are weathered and locally are part of the solum of the Modern Soil.

Interpretation

Malden unit 1. The lowermost diamicton in the Malden Till Member is interpreted to be basal till and sediment of basal origin that has undergone resedimentation. A meltout origin is suggested for some of the diamicton because of the somewhat variable texture and clay mineral composition (table 4) and the presence of thin lenses of sorted sand and gravel. Fabric diagram 11 (fig. 8) shows a weak but statistically significant preferred orientation of pebbles parallel to ice flow direction as indicated by striae on boulders below the fabric site. Pebble dips average about 18° in an up-ice direction. Reorientation of pebbles during deposition may account for the weak fabric. Locally, sand and silt stringers, gravelly lenses, and clusters of coarse clasts in some of the diamicton appear to be related to sediment flow.

The discontinuous line of boulders with striations parallel to ice flow direction at the base of the diamicton indicates glacial traction and erosion. The presence of another striated boulder pavement within massive diamicton at Pit 6 argues for a lodgement origin for some of the till in unit 1.

The color and clay mineral composition of diamicton in unit 1 is intermediate between that of the underlying red-gray diamicton (Tiskilwa) and the overlying gray diamicton of unit 2. This intermediate composition could have resulted from incorporation and mixing of previously deposited red-gray diamicton into the basal debris zone of the advancing Malden ice. In this case, its origin would be similar to that of the lower unit of the Tiskilwa Till Member.

Alternatively, the boulder pavement and the overlying diamicton might have resulted from the same glacial event that produced the red-gray diamicton of the Tiskilwa Till Member. The boulder pavement possibly indicates an interval of nondeposition after which till deposition recommenced. Because the overlying till of unit 2 has a different color and composition, the basal debris in the ice sheet must have changed as a result of entrainment of different source material from either the same or a different area. The succession of deposits, according to this interpretation, would be an example of "conformable facies superimposition" (Eyles et al., 1982). Evidence for either interpretation is inconclusive at Wedron.

We interpret the upper part of the main unit of the Tiskilwa Till Member, in some places in Pit 1, to be ice marginal and/or supraglacial in origin. This interpretation suggests that Malden unit 1 was deposited during a subsequent readvance of the ice margin; however, because unit 1 diamicton is missing from the section at this location, we do not know exactly when these ice-marginal deposits accumulated, and therefore cannot conclude that an ice margin retreat east of Wedron occurred after deposition of the main Tiskilwa unit and before deposition of unit 1.

The overlying discontinuous beds and lenticular bodies of more variable diamicton in unit 1 are probably the result of sediment flow in the ice-marginal environment. This origin is suggested by the presence of silt and clay stringers, gravel-size clast clusters, weak fabric (fabric 9, figs. 8 and 16), and gravel-size inclusions of underlying material. A sediment flow origin also is suggested by the close association of these diamictons with crudely bedded, gravelly silty sand, and finer-textured sorted sediment. Although some may be of subaerial origin, locally they contain contorted laminae and diapiric and water escape structures that are interpreted as indicating rapid deposition in a subaqueous environment and subsequent dewatering. A lacustrine origin also is inferred for the well-sorted and extensive silt and fine sand unit that is present at the top of unit 1.

Malden unit 2. A break in lacustrine sedimentation or significant change in the depositional environment is indicated by the abrupt contact between the silt and overlying silty clay, and the local occurrence of a thin, coarse, sand bed at the contact. A change in sediment source also is suggested by the fact that the silty clay contains more illite than does the underlying silt (table 4); we infer that the silt is related to unit 1 diamicton and the silty clay to the overlying unit 2 diamicton.

The silty clay probably indicates a more quiescent lake environment, farther from the ice margin, in which fine-grained sediment was deposited from suspension. The upward gradation to silty clay diamicton having more abundant pebbles and a larger percentage of sand probably reflects an influx of ice-rafted debris associated with an advancing ice margin. The unit has a random to very weak pebble fabric (fig. 8) that is compatible with a lacustrine origin.

The overlying diamicton, characterized by massive structure with few lenses and layers of sorted sediment, fairly uniform texture, and somewhat variable clay mineral composition, is interpreted as basal till, probably deposited by meltout. Fabric diagram 4 (fig. 8) shows a preferred orientation of pebbles roughly parallel to regional ice flow direction. A nearly horizontal 4° pebble dip down-ice can be attributed to differential settling during the meltout process. The large inclusions of Tiskilwa and other diamictons that have been observed locally in Pit 1 are interpreted to be the result of glacial deformation.

The overlying interbedded diamicton and sorted sediment of more variable character probably represent material that has undergone resedimentation in the ice-marginal environment. The redder color and lower illite composition of these diamictons may reflect mixing of far-travelled englacial debris or inclusions of Tiskilwa diamicton with Malden unit 2 diamicton during resedimentation.

Malden Unit 3. The sand of unit 3 is interpreted to be outwash, probably related to the overlying clay diamicton. Further study is needed to more fully evaluate the origin and regional extent of unit 3. Two alternative interpretations appear to be possible.

The texture of the diamicton is similar to that of the Yorkville Till Member that is present in the Marseilles Morainic System located just east of Wedron and across the Fox River. The outwash may make up an outwash plain related to the ice margin position inferred from the end moraine. The diamicton could be the result of one or more sediment flows on the outwash surface. This was our original interpretation at a time when our observations suggested that the diamicton was thin and rarely present in section. However, the diamicton contains less illite than typical diamicton in the Marseilles Morainic System (Yorkville Till Member), according to H. D. Glass (personal communication).

Recent observations in a new exposure in Pit 6 indicate that Malden unit 3 is thicker than previously thought. It may have regional significance, as is suggested by the reported occurrence of silty clay loam diamicton west of Wedron (Jones et al., 1966), the occurrence of soils developed in silty clay and clay diamicton mapped west of Wedron (Alexander et al., 1972), and the fine-grained diamicton (Yorkville Till Member) mapped south of the Illinois River to the west of Wedron (Lineback, 1979) (fig. 4). These observations suggest that relatively fine-grained diamicton was deposited during a regional ice event that extended west of Wedron. Willman and Frye (1970) included the fine-grained deposits in the Malden Till Member. Malden unit 3 at Wedron is probably related to these deposits, but further regional work must be done before we can make a definite interpretation.

Summary: Malden succession. At least one definite ice margin advance is evident in the Malden succession at Wedron. The advance is implied by the proglacial and glacial deposits of unit 2. Because of the lack of conclusive evidence for an ice margin retreat between the deposition of the underlying main unit of the Tiskilwa and unit 1 of the Malden, we cannot conclude that unit 1 represents an earlier Malden ice margin advance. On the basis of regional relationships, unit 3 may be related to a later Malden ice margin advance or, alternatively, may be related to the Yorkville ice margin advance associated with the Marseilles Morainic System east of Wedron.

Discussion

Tiskilwa Till Member-Malden Till Member contact. The Tiskilwa-Malden contact at Wedron is placed at what is considered to be the best field contact and where it best meets contact criteria as described in the definition of the units by Willman and Frye (1970). The contact is marked by a boulder pavement and a change in color, texture, and clay mineral composition of diamicton in the two units (fig. 8, table 4). Even though ice margin retreat to Wedron cannot definitely be inferred, the contact represents an important compositional change recorded regionally throughout much of the area covered by the Wedron Formation in Illinois (Willman and Frye, 1970; Johnson, 1976). It probably represents an ice margin retreat and readvance in some areas, but the extent of the retreat may have been overinterpreted on the basis of the Wedron Section (Frye and Willman, 1973) and regional correlations related to the Lemont drift (Johnson, 1976, and discussion at Stop 2).

Relationship of Willman and Frye section to current exposures. Willman and Frye (1970) recognized four drift units within the Malden Till Member (table 3). Their published section is a composite based on observations in 1957, 1959, 1964, and 1965, and on the basis of our review of field notes, includes some of Willman's earlier observations. Although relationships between the published composite section (Willman and Frye, 1970, table 3) and those currently exposed at Wedron are not definite, from youngest to oldest we suggest the following relationships:

> Farm Ridge Drift. Although this unit was described as a silty till in table 3, some of Willman's earlier field notes record it as silty and clayey, and it probably is equivalent to the fine-grained diamicton in our Malden unit 3. Sand and gravel lie below it in both successions.
>
> Mendota Drift. This till was described in table 3 as silty and bouldery. It either is not exposed currently or it may be the same as some of the gravelly diamicton that locally is present in the upper part of our Malden unit 2 in Pit 6. The latter is possible because Willman and Frye (1970) reported only 6 inches (15 cm) of sand between it and the subjacent unit.
>
> Arlington Drift. The texture of till in this unit was not described in table 3, but it overlies silt and includes some sand; a sample of clay was reported above the silt (table 3). This sequence probably is equivalent to the loam diamicton and silty clay in Malden unit 2 and the pervasive silt in Malden unit 1. Willman (unpublished field notes, 1931) described the silty clay as waterlaid till with few pebbles.

Dover Drift. This till was described in table 3 as a gray, silty till containing a few pebbles. It is either not currently exposed or is equivalent to the loam diamicton in Malden unit 1. The uncertainty relates to whether Willman and Frye (1970) included the latter diamicton in the Malden or Tiskilwa Till Member. Their field notes in 1965 describe it as the first gray till above the Bloomington (Tiskilwa) and this agrees with our observation.

To summarize, although many of the main elements of the Malden described by Willman and Frye are still exposed, one or two elements may not be present. We think the most important and significant elements are present.

Regional stratigraphic problems

The section at Wedron illustrates existing lithostratigraphic problems of the Malden Till Member. Of the three diamicton units present, diamicton interpreted to be till in Malden unit 1 and Malden unit 2 is relatively similar, at least from the standpoint of texture. Diamicton in Malden Unit 3, however, is much finer grained, lithologically dissimilar, and more like the Yorkville Till Member than like the lower two units.

The Malden was defined by Willman and Frye (1970) as a silty, locally sandy, till that overlies the Tiskilwa Till Member and underlies the Yorkville Till Member. Conceptually it included those tills that are at land surface beyond the Marseilles Morainic System, considered to be the margin of the Yorkville Till Member by Willman and Frye (1970), out to the Bloomington Morainic System that is composed of the Tiskilwa Till Member (figs. 1, 2). At the type section (the Malden South Section), the Malden was described as silty and sandy; however, grain size analyses indicate that the matrix is a silty clay loam (7 samples ranged from 15 to 18% sand, 38 to 44% silt and 38 to 45% clay). It is located in an area of Dover Drift but texturally is most similar to Malden unit 3 or possibly part of Malden unit 2 at Wedron.

The Malden is a texturally variable unit. In the northern part of the Princeton Sublobe it is mostly loam (S. Wickham, 1979). Jones and others (1966) reported that samples of diamicton collected from both the Farm Ridge and Arlington Moraines north of the Illinois River ranged from loam to silty clay loam. South of the Illinois River much of the area mapped as Malden by Willman and Frye (fig. 1) was mapped as Yorkville (fig. 4) by Lineback (1979) because the diamicton is so fine grained. It appears that, if the original concept of the Malden is maintained, the unit will be quite variable from a textural standpoint, and much of it may not be distinguishable in the field from the Yorkville Till Member except by its location with respect to moraines. If the Yorkville is extended westward to include the finer grained diamicton as was done south of the Illinois River by Lineback (1979), it may include the type section of the Malden. In order to maintain some continuity with the original concept of the unit and to maintain established nomenclature, an alternative is to recognize a fine-grained facies of the Malden and to use a vertical cutoff to separate it from the Yorkville Till Member.

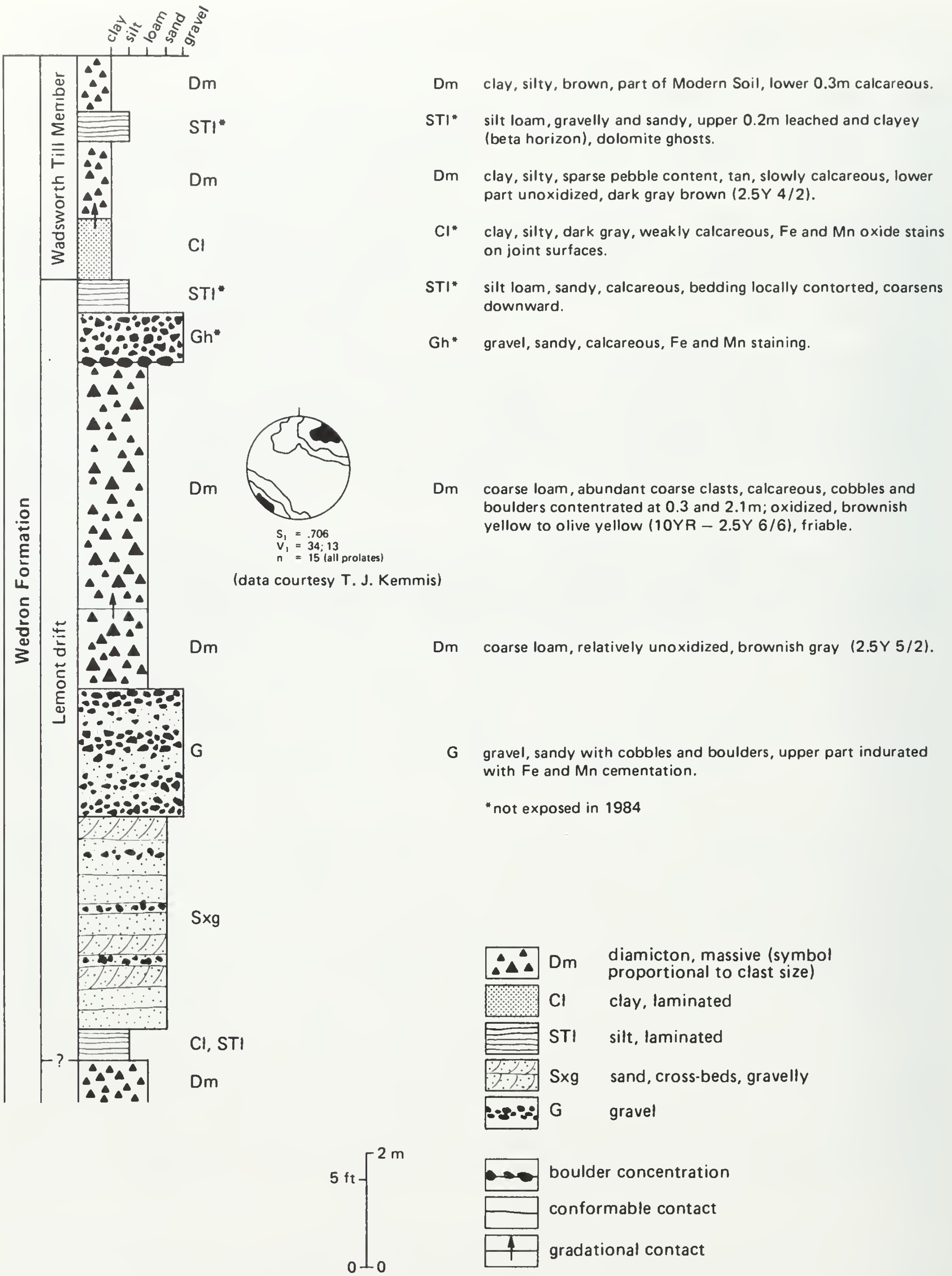
On a more regional basis, the three units currently exposed at Wedron are similar in character, texture, and sequence to three members that have been defined in the Decatur Sublobe in east-central Illinois (fig. 4): the Piatt, Batestown, and Snider Till Members (Johnson, 1976; J. Wickham, 1979). Similar nomenclature problems exist in the Decatur Sublobe between the Yorkville and Snider Till Members.

HENRY FORMATION; RICHLAND LOESS

Several deposits of sand and gravel occur at or near the ground surface and are included in the Henry Formation. The gravelly sand in Malden unit 3 locally occurs beneath a surficial silt where the clay diamicton is not present (fig. 7). In these situations the exhumed gravelly sand has been included in the Henry on surficial maps of the area. Where this unit passes under the diamicton, a vertical cutoff is arbitrarily assigned to restrict the Henry Formation to be a surficial unit. The buried portion is included in the Malden. In other places a pebbly clay loam lag overlies the gravelly sand--or the diamicton where present--and is buried by the surficial silt.

The main part of the Henry Formation is represented by a weathered sand (Sh(p)) that overlies the clay diamicton in the NW corner of Pit 6 where the exposure intersects the highest ground-surface elevation. Many sand and gravel pits in the area are located on this high terrace level. Although the weathered sand (clay loam) appears restricted to the lower part of the Modern Soil, it is interpreted here to represent a thin portion of the outwash of the Henry Formation.

In all locations where the surficial silt (STm(p)) has been observed it is weathered to a silt loam or silty clay loam in the Modern Soil. This silt is correlated to the Richland Loess described by Willman and Frye (1970).



Dm	clay, silty, brown, part of Modern Soil, lower 0.3m calcareous.
STl*	silt loam, gravelly and sandy, upper 0.2m leached and clayey (beta horizon), dolomite ghosts.
Dm	clay, silty, sparse pebble content, tan, slowly calcareous, lower part unoxidized, dark gray brown (2.5Y 4/2).
Cl*	clay, silty, dark gray, weakly calcareous, Fe and Mn oxide stains on joint surfaces.
STl*	silt loam, sandy, calcareous, bedding locally contorted, coarsens downward.
Gh*	gravel, sandy, calcareous, Fe and Mn staining.
Dm	coarse loam, abundant coarse clasts, calcareous, cobbles and boulders contentrated at 0.3 and 2.1m; oxidized, brownish yellow to olive yellow (10YR – 2.5Y 6/6), friable.
Dm	coarse loam, relatively unoxidized, brownish gray (2.5Y 5/2).
G	gravel, sandy with cobbles and boulders, upper part indurated with Fe and Mn cementation.

*not exposed in 1984

FIGURE 17. Composite section, lithofacies, descriptions, and pebble fabric at the Lemont pit. Modified from Bogner (unpublished).

THE LEMONT SECTION: STOP 2

W. Hilton Johnson and Ardith K. Hansel

INTRODUCTION

The Lemont drift was named by Bretz (1939) for exposures along the south valley bluff of the Des Plaines River about 1 mile west of Lemont. We will visit the type section, which is still relatively well-exposed. The Lemont was described in considerable detail by Bretz (1955) and Horberg and Potter (1955), and the major questions at that time were: What is the age of the Lemont? Does it correlate with other recognized till units? Why is the composition of the Lemont so different from the overlying clayey "till"? The questions are still pertinent today, and will be the focus of the field trip discussion.

We have not done extensive work on the Lemont drift, and our discussion relies heavily on the earlier observations and work of Bretz (1955), Horberg and Potter (1955), and Krumbein (1933), and on more recent work by Landon (1967), Landon and Kempton (1971), and Bogner (1973).

DESCRIPTION

The Lemont Section exposes 4.1 m of the Wadsworth Till Member, Wedron Formation over 15.5 m of Lemont drift (Bogner, 1973). (We refer to the upper fine-grained diamicton at Lemont as Wadsworth in the following discussion. Bogner referred to it as Wadsworth-Yorkville. See following discussion section.) The two units are distinct and the section description (fig. 17) is a modification of an unpublished description by J. E. Bogner. Not all of the succession is currently exposed.

At the north end of the pit, a complex succession (not shown in fig. 17) of stratified silts and sands, laminated silt and clay, and pebbly silt loam and loam diamicton is exposed in the lower part of the section. Pebbles in the latter two deposits are angular. The deposits probably lie stratigraphically below the Lemont drift or are related to the basal part of the Lemont. Bogner (fig. 17) described a "till" (Dm) below the Lemont, and the pebbly deposits may correspond to that unit; however the clay mineral composition of samples from the two units differs (table 5).

The lower part of the Lemont drift consists of stratified and sorted deposits that currently are not well-exposed. Bogner (fig. 17) described a coarsening upward succession ranging from laminated silt and clay (Stl,Cl) at the base, to cross-bedded sand and gravel (Sx), to a coarse facies dominated by crudely bedded cobbles and boulders (G). Cross-beds generally dip to the southeast. Similar sequences have been observed elsewhere in the area.

Diamicton (Dm) in the Lemont is a brownish yellow to olive-yellow (10YR - 2.5Y 6/6) silt loam to sandy loam that contains abundant coarse clasts and is massive, friable, and calcareous. Where the diamicton is relatively unoxidized, it is brownish gray (2.5Y 5/2). Most coarse clasts are dolomite. Appreciable quantities of chert are also present. A relatively strong pebble fabric, measured approximately in the middle of the diamicton, has a mean axis azimuth of 34° and a plunge of 13° (fig. 17). This section contains more diamicton than most sections that have been described in the Lemont area. Bogner reported thin sands and silts interbedded with diamicton locally in the upper part of the Lemont drift, and observed a fining upward succession of gravel (Gh) and silt (STl) at the top of the unit (fig. 17).

The Wadsworth, as currently exposed, abruptly overlies the Lemont; it is a silty clay diamicton with a sparse pebble content. It is calcareous, unstratified, firm, has a platy to blocky structure, and is dark grayish brown (2.5Y 4/2) above the contact, except locally where the lowest 10 cm is more oxidized.

Data resulting from our current study and from previous research on grain size and composition of the Wadsworth and Lemont diamictons are:

Grain size. Two samples of diamicton from the Wadsworth contained about 2% sand, 52% silt, and 46% clay in the < 2-mm fraction; five samples of diamicton from the Lemont averaged 40% sand, 48% silt, and 12% clay (table 5). The Lemont is more variable texturally; for example, sand content varied from 26 to 50%. On a more regional basis, Bogner's (1973) textural data are similar to our data except that her Wadsworth samples commonly contained slightly more sand. The other major textural difference between the two units is that coarse clasts are many times more abundant in the Lemont diamicton than in the Wadsworth diamicton.

Clay mineral composition. Two samples of relatively unoxidized diamicton from the Wadsworth contained 2% expandable clay minerals, 81% illite and 17% kaolinite plus chlorite in the clay fraction (table 5). Two samples of relatively unoxidized Lemont contained about 5% expandable clay minerals, 75% illite, and 20% kaolinite plus chlorite.

Carbonate content. Horberg and Potter (1955) did a complete compositional analysis of the clay, sand, and gravel fractions of two samples of Lemont diamicton. All gravel fractions and sand fractions coarser than 0.5 mm contained more than 90% dolomite particles; the 0.25- to 0.5-mm fraction contained about 65%, the 0.125- to 0.25-mm fraction about 40%, and the .062- to .125-mm fraction contained about 12%. They reported no dolomite in the clay fraction and assumed there would be only small amounts in the silt fraction because of the rapid decrease of dolomite in the finer sand fractions. However, Chittick analyses of the < 74-µm fraction of three samples of Lemont averaged 5% calcite and 50% dolomite and some (or much) of the calcite may be easily dissolved dolomite (table 5). Thus, contrary to Horberg and Potter's assumption, the silt fraction of Lemont diamicton contains abundant dolomite.

Krumbein (1933) reported that the pebble fraction of Wadsworth diamicton north of Lemont contained more than 80% dolomite pebbles (6 samples) but southeast of Lemont it contained only about 11% dolomite pebbles (4 samples). A sample near Lemont contained 42% dolomite pebbles. Chittick analyses of the < 74-µm fraction of two samples of Wadsworth diamicton from the Lemont Section contained about 3% calcite and 32% dolomite.

Shale pebbles. Horberg and Potter (1955) reported a negligible number of shale pebbles in Lemont diamicton. Krumbein (1933) estimated the shale and silt pebbles in the Wadsworth diamicton north of the Lemont area to be approximately 10% (6 samples), but more than 80% southeast of Lemont (4 samples). A sample from the Lemont area contained 49% shale and silt pebbles.

Chert pebbles. Horberg and Potter (1955) reported that chert pebbles (about 2 to 10% by number) are relatively abundant in the 0.5-mm to 64-mm size fractions of Lemont diamicton. They observed that the upper size limit of the chert corresponds well with the known size of chert nodules in Silurian dolomite in northern Illinois. Chert is a small to negligible component (included in a miscellaneous category) of the pebble fraction of Wadsworth diamicton (Krumbein, 1933).

Igneous and metamorphic pebbles. Horberg and Potter (1955) reported that the composition of igneous and metamorphic pebbles in the Lemont drift diamicton is similar to that of the Wadsworth diamicton (no statistically significant differences). The igneous and metamorphic pebble fraction of each contains about 38% phaneritic acid igneous, 12% phaneritic basic igneous, 44% diabase, 4% metamorphic and 2% volcanic rocks (4 samples of Lemont and 3 samples of Wadsworth).

TABLE 5. Grain size, clay mineral, and carbonate data for the Lemont Section.

Stratigraphic unit	Lithofacies	% gvl[1]	Grain size matrix[2] % Sd	% Si	% C	Clay mineral composition[3] % E	% I	% K+C	Carbonate composition[4] % Cal.	Dol.	Sample number
Wadsworth T.M.	Cm	0	2	53	45	2	81	17	6	31	WHJ-83-63
		0	2	52	46	2	81	17	1	33	WHJ-83-64
Lemont drift		8	38	49	13	7	81	12*	3	48	WHJ-83-65
		27	50	42	8	-	-	-	7	50	WHJ-83-66
	Dm	20	48	43	9	-	-	-	5	53	WHJ-88-67
		4	26	61	13	10	81	9*	-	-	8-84-84
		5	40	47	13	6	75	19	-	-	8-84-85
		-	-	-	-	4	75	21	-	-	JB-33**
	Ave	13	41	48	11	5	75	20			
					n = 5	n = 2 (unoxidized)					
Pre-Lemont		14	22	57	21	2	80	18	-	-	WHJ-84-68
	Dm	-	-	-	-	8	72	20	-	-	JB-34**

[1] Percent of whole sample
[2] Percent of < 2-mm fraction
[3] Percent of < 2-µm fraction
[4] Percent of < 74-µm fraction
*Oxidized sample
**Data from J. E. Bogner (1973)

Pebble shape. Horberg and Potter (1955), using the Krumbein (1941) roundness chart, analyzed the roundness of 16- to 32-mm dolomite pebbles collected from Wadsworth diamicton, Lemont diamicton, and outwash at 18 localities. Pebbles in the two diamictons were more angular (means, .33 and .36) and not statistically different; pebbles from the outwash were more round (mean, .49).

INTERPRETATION

Although we have not studied the section in detail, our observations agree with the general interpretations of Bogner (1973) and earlier researchers. Bogner interprets the lower, coarsening upward part of the unit as the result of proglacial lacustrine and fluvial sedimentation. This succession eventually was overridden by an advancing ice margin, and diamicton of the Lemont was deposited; this diamicton probably includes both till and sediment flow deposits. Ice-contact deposits and a fining upward succession of sorted deposits (fig. 17) accumulated during deglaciation and ice margin retreat. Bretz (1955) suggested that valleys were eroded in the Lemont prior to their burial by Wadsworth Till. The Wadsworth was deposited during a subsequent ice margin advance and generally is thin along the Des Plaines River valley (Bretz, 1955).

DISCUSSION

COMPOSITION AND CHARACTER OF LEMONT AND WADSWORTH DIAMICTONS

The strongly contrasting character and composition of the two diamictons is obvious, yet both occur in the same general area. Researchers previously related these differences to both the bedrock geology of the Lake Michigan Basin (fig. 18) and the Woodfordian deglaciation history.

The dolomitic character of the Lemont diamicton clearly is the result of "local loading" of the ice sheet by erosion of Silurian dolomite (Horberg and Potter, 1955). The ice margin advanced up the backslope of a regional cuesta in an erosive regime. The particle size distribution in the Lemont diamicton suggests a relatively short transportation distance with a dominance of dolomite in the gravel fraction but also significant quantities in the matrix fraction (Bogner, 1973). Horberg and Potter (1955) suggested that much of the fine sand, silt, and clay was derived from proglacial sorted deposits, but the bimodal dolomite distribution likewise can be explained by comminution principles developed by Dreimanis and Vagners (1969). The size and abundance of chert also suggests a local bedrock source, and the angularity of the dolomite pebbles indicates that they were eroded directly from the bedrock and transported by the ice sheet and were not derived indirectly from the subjacent outwash.

The small number of shale pebbles in the Lemont led Bretz (1955) to suggest that the ice sheet was moving in a southerly direction and that the Lemont was deposited by ice that flowed only over Silurian dolomite along the flank of the Lake Michigan Basin, not by ice flowing out of the Basin. Such a flow path seems unlikely; comminution of shale and dilution by dolomite appear adequate to explain the small number of shale pebbles without resorting to an ice-flow direction not supported by other evidence. Bretz reports that striae on bedrock beneath the Lemont have an azimuth of 55°.

The lack of appreciable amounts of clay and the presence of only moderate amounts of nondolomitic silt in Lemont diamicton suggest that significant lake deposits were not present in the Lake Michigan Basin immediately prior to the ice margin advance that resulted in deposition of the Lemont. Assuming that the Lemont is Woodfordian (see following discussion), previous ice margin retreats in the Woodfordian either did not extend far back into the Basin or most of the lake sediment that might have accumulated in an early proglacial lake in the Basin had been eroded. Both scenarios are possible and have significance with respect to the source of abundant silt and clay in the Yorkville Till Member and to interpretations of ice margin fluctuations during the Woodfordian. Proglacial lake deposits are present below Lemont outwash along the flank of the Basin (Bogner, 1973).

The silty and clayey character of Wadsworth diamicton and other fine-grained units in Illinois has been attributed to the incorporation of proglacial lake sediment deposited in one or more early lakes in the Lake Michigan Basin (Krumbein, 1933). Schneider (1983) inferred the existence of a lake in the Basin prior to formation of the Valparaiso Morainic System, and named it Lake Milwaukee. Another possible explanation for the fine-grained texture of the Wadsworth is the incorporation and comminution of Devonian shale (fig. 18) from the Lake Michigan Basin (Willman and Frye, 1970). The bedrock of the Basin probably affected the composition of the Wadsworth, as Krumbein's 1933 data on pebble lithology suggest. The Wadsworth southeast of Lemont contains abundant shale pebbles and the Wadsworth north of Lemont contains abundant dolomite pebbles, reflecting the spatial bedrock patterns in the Basin. This

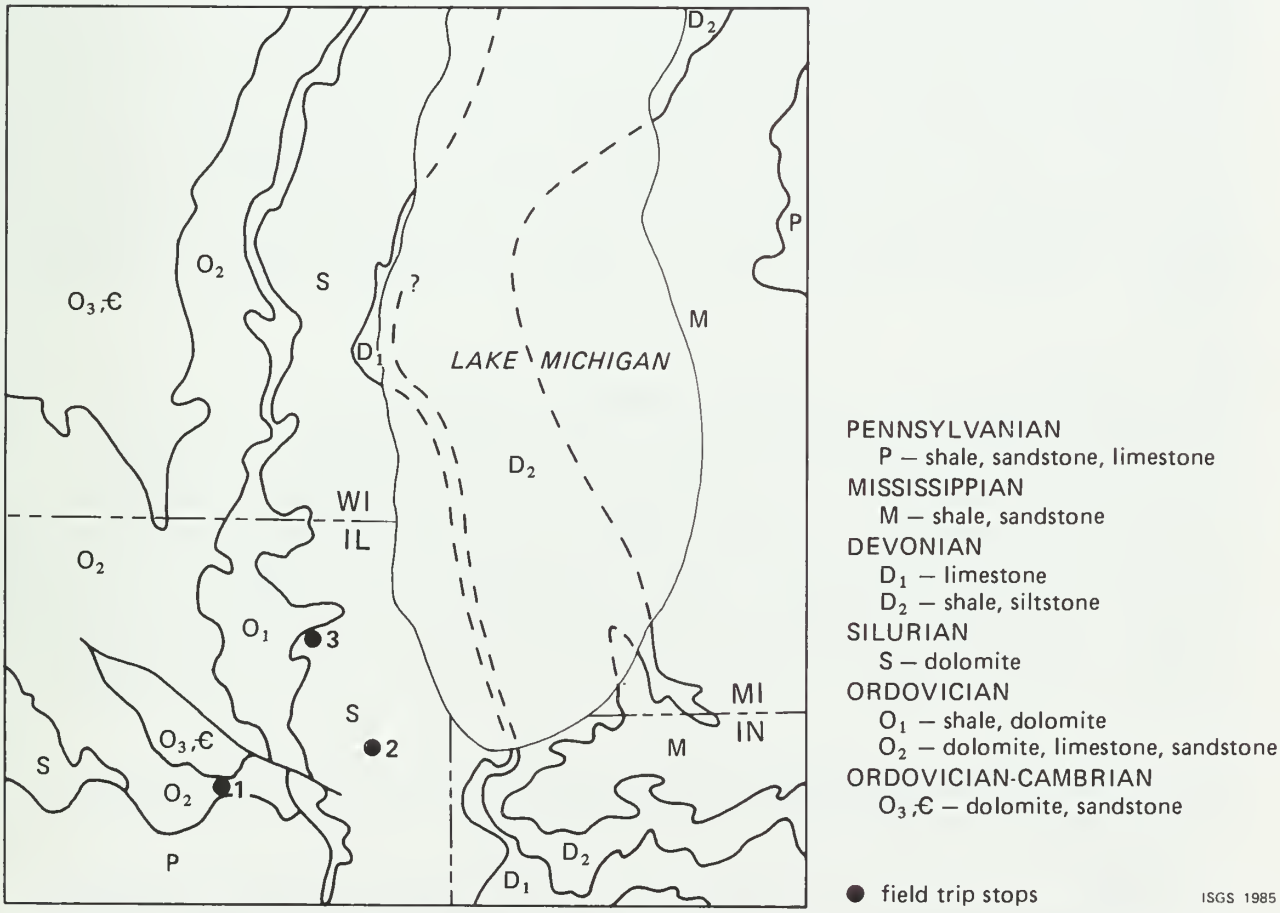


FIGURE 18. Generalized bedrock geology of southern Lake Michigan Basin area. After USGS Geological Map of the U.S. (1974).

strong lateral contrast in pebble composition, however, is not known to occur in the silt and clay fractions; neither is the matrix texture known to change significantly north and south of Lemont (critical testing of these statements remains to be made). These relationships indicate that although bedrock affected the composition and texture of the Wadsworth to some extent, incorporation of proglacial lake deposits was most responsible for the fine-grained texture of the unit.

AGE OF THE LEMONT DRIFT

Observations and interpretations of weathered materials in the upper part of the Lemont have raised questions about its age. These materials were described first by Horberg and Potter (1955) at three localities. The described materials were clayey, leached of carbonate, red-brown to yellow-brown, and at one locality, 78 inches thick. The weathered materials were either stratified sand and gravel or silt. Horberg and Potter (1955) interpreted the materials to be part of a buried soil that probably correlated with the Sangamon Soil, and they suggested that the Lemont drift was Illinoian. Bretz (1955) thought the Lemont probably was Illinoian or possibly late Wisconsinan; Frye and Willman (1960) suggested that the buried soil might correlate with the Farmdale Soil and, if so, that the drift might be early Wisconsinan (Altonian).

Bogner (1973) interpreted the weathered material to be the result of modern weathering processes rather than part of a buried soil. She reported that weathered materials were present not only at the top of the Lemont, but also within the Lemont and the Wadsworth, and that they were always associated with stratified drift. Such weathered material can result from modern weathering processes where they have extended downward through joints in the overlying diamicton or through sand and gravel where it has a lateral connection to the surface or is near the surface. Weathering zones of this type have been termed Beta horizons (Bartelli and Odell, 1960); they commonly form in coarse, stratified deposits that are relatively more permeable than the overlying deposit. These weathered materials are not evident at the section currently exposed at Lemont, but were observed by Bogner. We accept Bogner's interpretations. If Bogner's interpretation is correct, the Lemont likely is Woodfordian.

STRATIGRAPHIC POSITION AND CORRELATION OF THE LEMONT DRIFT

The Lemont drift lies stratigraphically below the Wadsworth Till Member. Its relationship to other till members of the Wedron Formation, however, is not definite. Correlation has been suggested with the Malden Till Member (Landon and Kempton, 1971; Bogner, 1973), and Willman and Frye (1970) observed that it is lithologically most similar to the Haeger Till Member. The correlation with the Haeger appears likely on the basis of lithology, stratigraphic position, and spatial relationships. If the Lemont is also correlative with the Malden Till, significant modification of the stratigraphic succession in northern Illinois would be necessary. The Lemont-Haeger correlation will be discussed at Stop 3 where the Haeger Till Member will be observed.

Correlation of the Lemont drift with the Malden Till Member has been based on the following observations and interpretations:

- Landon and Kempton (1971) and Bogner (1973), on the basis of subsurface studies, suggested that the stratigraphic succession at Lemont (Wadsworth

Till over Lemont drift) can be traced both northwest (toward the area of Haeger Till) and to the west beyond the area of Wadsworth Till (the West Chicago Moraine). In the latter area the clayey surface diamicton is mapped as Yorkville (fig. 4) and the subjacent loam till is considered to be Malden. Thus, they concluded that Wadsworth correlates with Yorkville and Lemont with Malden. The correlations were based on similar stratigraphic successions and generally similar diamicton textures and clay mineral compositions.

- Fisher (1925) described cemented gravels (referred to as Joliet Outwash Plain) that were exposed in the lower Des Plaines Valley; they extended to bedrock locally and were buried by Valparaiso Drift (as at Lemont) and by Rockdale Drift west of the West Chicago Moraine. Fisher suggested that the basal outwash at Lemont extended west in the subsurface to areas where Yorkville is now mapped (area of the Rockdale Moraine). Fisher interpreted the gravels to be younger than Minooka Drift (Yorkville) and older than Rockdale Drift (Yorkville).

Bretz (1955) agreed with Fisher's interpretations, except that he suggested that the gravels were older than Minooka (Yorkville) and younger than Marseilles Drift (Yorkville). Bretz also suggested that the gravels might correlate with gravels near Elgin (called Algonquin gravel formation) that he stated were overlapped by the Minooka Moraine. The latter relationship was based on geomorphic interpretations by Leighton (1925) who felt that the Fox River valley had been cut through the gravels prior to the Minooka glacial advance. The Minooka Moraine (as well as the West Chicago Moraine) was interpreted to extend down into the previously eroded valley where it crosses the Fox River. Leighton and other early geologists considered these gravels to be related to retreat of the Marseilles ice margin. These gravels, associated with the Haeger Till Member north of Elgin, will be discussed at Stop 3. They are not known to occur below Minooka Drift or Yorkville Till north of Elgin, and sedimentological study indicates that they are proglacial in origin (Cobb and Fraser, 1981; Fraser and Cobb, 1982).

Kemmis (1979) described two sections in gravel pits 3.5 km apart in areas of Minooka Drift (Yorkville) and West Chicago Drift (Wadsworth) near Naperville (about one-third of the way from Lemont to Elgin). In both pits, fine-grained diamicton overlies thick stratified sand and gravel. Diamictons of the Minooka and West Chicago Drifts are similar, except for slight textural differences, and Kemmis did not speculate on stratigraphic relationships between the two drifts. A regional stack-unit map of northeastern Illinois (Kempton et al., 1977) shows extensive areas of fine-grained diamicton overlying outwash along the West Branch of the Du Page River. Some of the diamicton was mapped as Yorkville and some as Wadsworth.

Collectively, these observations related to buried outwash suggest that proglacial Lemont outwash may extend beyond the West Chicago Moraine (Wadsworth Till) and that west of the moraine the outwash may be buried by diamicton currently mapped as Yorkville Till. Although the observations do not relate directly to the Malden Till Member, they suggest that Wadsworth diamicton may extend farther west than currently mapped.

- The Lemont drift is lithologically distinct from Malden Till to the west, as at Wedron, and to the northwest. Lemont diamicton is more dolomitic and contains more gravel, sand, and silt but less clay than the Malden. Their clay mineral compositions are similar. Such lithologic contrasts may not be unreasonable, however, considering that the ice sheet would have moved over older drift and younger Paleozoic units (particularly Maquoketa Shale Group; O_1 in fig. 18) west of the Lemont area. The observed changes in diamicton character could have resulted from incorporation of and dilution by these latter materials (Bogner, 1973), and further comminution of the dolomite.

- Samples of the fine-grained diamicton (upper unit) at Lemont contain large proportions of illite (about 80%; table 5) and have the same clay mineral composition as Yorkville diamicton in the Marseilles Morainic System to the west. H. D. Glass (personal communication) believes that the upper diamicton at Lemont is Yorkville and that sediment with that clay mineral composition can be traced westward in the subsurface below diamicton with less illite (about 75%) that he considers to be Wadsworth. Thus, Glass interprets the Lemont to be older than Yorkville and, if so, conceivably it could correlate with the Malden.

Regional stratigraphic relationships suggest to us that the Lemont cannot be older than the Yorkville, which in turn negates correlation of the Lemont with the Malden Till Member. The following critical stratigraphic relationships occur in southern Will County and northern and western Indiana (fig. 19):

- As at Lemont, thick sand and gravel occurs below loam and fine-grained diamicton in southern Will County, about 20 km southeast of Lemont. We interpret this sand and gravel to be stratigraphically equivalent to the lower outwash in the Lemont drift, and the overlying diamictons to be Lemont and Wadsworth. The sand and gravel can be traced eastward in the subsurface to the Indiana state line (J. I. Larson, unpublished cross-section).

  An alternative stratigraphic interpretation, based on clay mineral composition, is that the sand and gravel is Yorkville in age (H. D. Glass, personal communication). Samples of the sand and gravel from two borings (NIPC 52, 55) along the cross-section contain about 80% illite in the clay fraction. Glass states that "this is the same unique clay mineral composition as that of the till in the Marseilles Morainic System (Yorkville) and it can be traced in the subsurface eastward to Lemont, where it overlies the Lemont drift. Till of the same clay mineral composition can only be traced in the subsurface to less than 10 miles south of Lemont, where outwash of the same composition is found (NIPC 52, 55)."

- In Indiana, the thick sand and gravel continues to the south and east in the subsurface below diamictons of variable character to the distal margin of the Valparaiso Moraines, at which point it is the surface unit along the northern side of the Kankakee Valley (Rosenshein, 1962). Rosenshein reports that it overlies "clay till" in the Valparaiso Moraine and south of the moraine.

- The surface of the sand and gravel in the Kankakee Valley has the morphology of a series of outwash fans extending beyond the Valparaiso

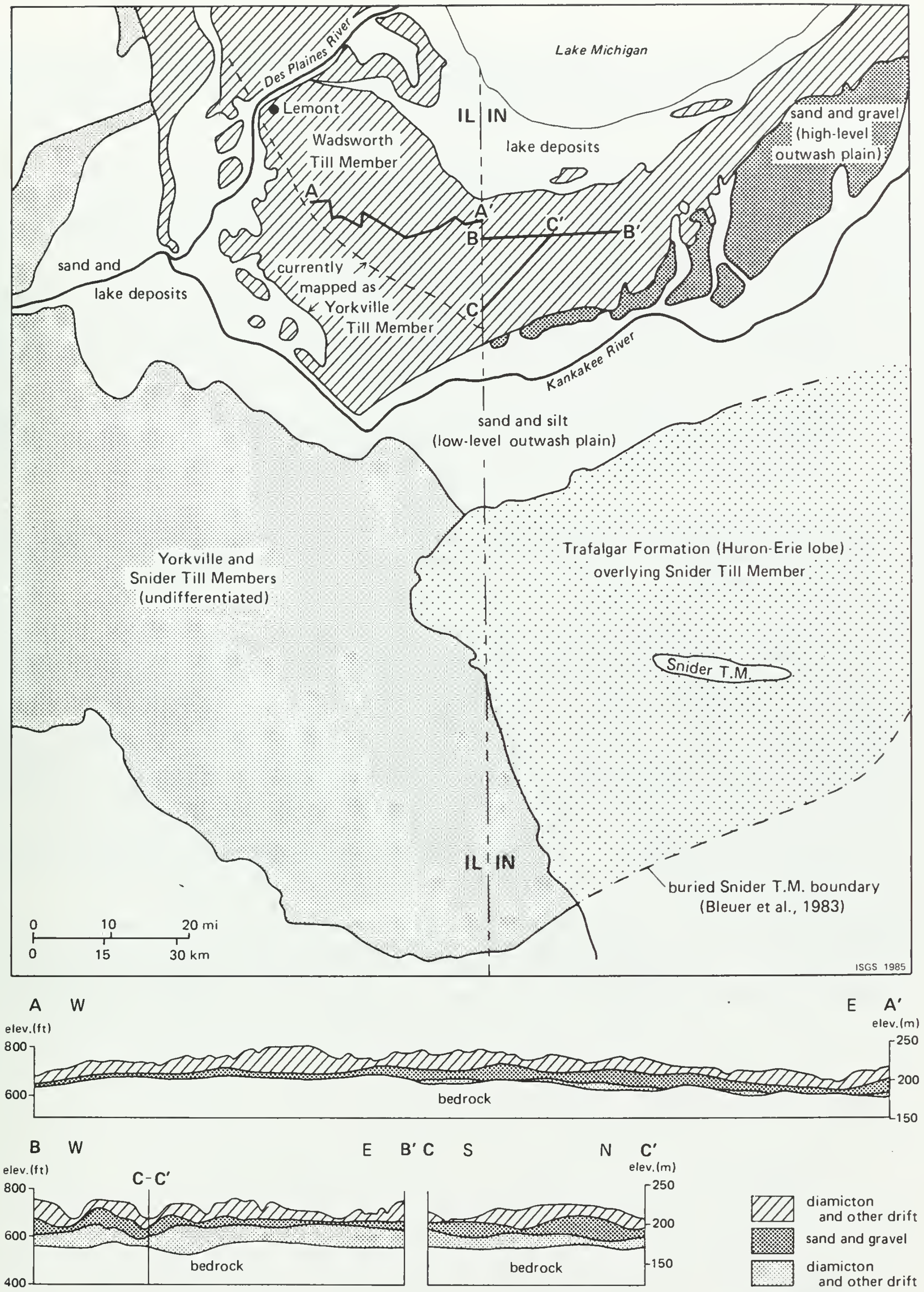


FIGURE 19. Simplified Quaternary map and cross-sections of northeastern Illinois and northwestern Indiana. Modified from Richmond and Fullerton (1983) and Schneider and Keller (1970); cross-sections from J. Larsen (unpublished) and J.S. Rosenshein (1962).

Moraine margin (Leverett and Taylor, 1915, p. 180; Schneider and Keller, 1970). It is a constructional outwash plain surface and shows no evidence of having been overridden by a subsequent ice margin advance (A. F. Schneider; G. S. Fraser, personal communications).

- In the Kankakee Valley the outwash unit overlies sand and lake muds (Nelson and Fraser, 1984). Locally, "till" interpreted to be Snider Till Member occurs below the lake beds (G. S. Fraser, personal communication).

- Extensive areas of Snider Till are known to occur at the surface and in the subsurface in northern and western Indiana south of the Kankakee Valley (Bleuer et al., 1983). Snider Till in Indiana is equivalent to the Snider and Yorkville Till Members in eastern Illinois (fig. 4) (Ned K. Bleuer, personal communication).

- Snider Till in Indiana and its equivalents in eastern Illinois had to be deposited before the sand and gravel, which occurs in the high outwash plain along the north side of the Kankakee Valley and probably is equivalent to outwash in the lower part of the Lemont drift.

Thus, if the subsurface correlation is correct, the Lemont must be younger than the Yorkville and Snider Till Members; it cannot correlate with the Malden Till Member.

Stratigraphic relationships are less clear in the Princeton Sublobe because (1) the Wadsworth ice margin advance extended farther west (see Epilogue) beyond the outwash plain that laterally separates the Wadsworth and Yorkville-Snider in Indiana; similar fine-grained diamictons are juxtaposed at land surface in Illinois; (2) both the Yorkville and Wadsworth Till Members apparently contain clay mineral zones of similar composition; and (3) the Malden-Yorkville and Lemont-Wadsworth successions have similar textural and compositional trends, the Malden-Yorkville succession occurring primarily west of the regional bedrock cuesta (Silurian dolomite) and the Lemont-Wadsworth east of it. Subsurface tracing of the Lemont sand and gravel will be most useful in stratigraphic separation of the two successions in this area.

Johnson (1976) utilized the Lemont-Malden correlation to infer major ice margin retreats to or near the Lake Michigan Basin both prior and subsequent to deposition of the Malden Till Member. In light of the foregoing observations, ice margin fluctuations of that magnitude do not appear warranted.

THE BEVERLY SECTION: STOP 3

Ardith K. Hansel, John M. Masters, and Betty J. Socha

INTRODUCTION

The Beverly pit is located along the front of a north-south trending segment of the West Chicago Moraine in an area mapped as Haeger Till Member (Willman and Frye, 1970; Lineback, 1979) (map, back cover, fig. 4). In the pit, up to 18 m of gravel is overlain by up to 6 m of yellow-brown to gray loam diamicton. This succession of deposits is typical of the Haeger Till Member in northeastern Illinois. The base of the pit (below groundwater level) is in gray, silty clay diamicton that probably correlates with the gray, silty clay diamicton of the Yorkville Till Member, exposed in a roadcut 5 km to the west. Sorted sediment of the Henry Formation locally overlies the Haeger at the Beverly pit. Up to 2 m of silt, Richland Loess, is present at the surface.

The Beverly pit is located at the southern margin of the area mapped as Haeger Till Member (fig. 4). In this area the Haeger overlaps gray, silty clay diamicton mapped as Yorkville Till Member to the west or, farther north in McHenry County where the Yorkville pinches out, the pink Tiskilwa Till Member. Both Yorkville and Tiskilwa have been found beneath the Haeger in the subsurface, although to the north the Tiskilwa is most often encountered. To the east in Lake County gray, silty clay diamicton mapped as Wadsworth Till Member overlaps the Haeger. The Haeger can be traced across the state line into Wisconsin, where it is mapped as New Berlin Formation from the Darien Moraine eastward to the front of the Valparaiso Morainic System (Schneider, 1983). In the Wisconsin nomenclature (Mickelson et al., 1984), the New Berlin Formation overlies the Tiskilwa Member of the Zenda Formation and is overlain by the Oak Creek Formation (equivalent to the Wadsworth Till Member).

The stratigraphic problem presented by the Haeger Till Member involves its correlation to other Wedron units south and east of the Harvard Sublobe area. A slight reentrant is present in the Elgin area at the junction of the Harvard and Joliet Sublobes (fig. 3). The main question is: Was the Haeger ice margin continuous across the Harvard and Joliet Sublobes or was the Haeger ice margin confined to a sublobe that did not extend to the southern Lake Michigan area? Lake Michigan Lobe ice apparently extended into the Harvard Sublobe during the Tiskilwa and Yorkville glacial phases because Tiskilwa and Yorkville are both mapped in that area (fig. 4). However, it may be that the Tiskilwa ice margin advance to the Marengo Moraine was earlier than the advance of the Tiskilwa ice margin to the Bloomington Morainic System (map, back cover) (S. Wickham, 1979). There also is some question as to the configuration of the ice margin across the Harvard and Princeton Sublobes during the Malden and Yorkville glacial phases. The gray, silty clay diamicton of the Huntley and Barlina Moraines (map, back cover; fig. 4) is mapped as Yorkville because it is similar to the Yorkville Till Member in the Princeton Sublobe, but these moraines become discontinuous in the Elgin-Fox River valley area and their connection with moraines to the south is uncertain. The geology and geomorphology of this area is complex because the ice margin extended farther west both to the north and south, but here where everything converges, relationships among morphology and deposits are not clear.

Subsurface work will be necessary to establish whether or not the Haeger can be traced to the outcrop area of other Wedron units. At this stop, we will examine the character and sedimentation of the Haeger Till Member in its type area and compare it to that of the Lemont drift examined at Stop 2.

EXPOSURES AT THE BEVERLY PIT

Active mining of the gravel and sand in the Beverly pit in the past decade has extended exposures northward. Exposures studied in the northeastern part of the pit in the summer and fall of 1984 have been destroyed by subsequent excavation. Figure 20 shows an east face of the Beverly Pit. This section was selected for study because it contains a relatively thick deposit of diamicton and also because it is located in an area that presently is not being mined. The gravel deposit is thickest in the northeastern part of the pit (fig. 21). During the field trip, we plan to visit the section shown in figure 20 and a section in the northeastern part of the pit. The gravel shown in figures 21 and 22 has been removed.

A composite section of the units exposed in the Beverly pit during the summer and fall of 1984 is represented in figure 23. Lithofacies descriptions and interpretations of the depositional environments of the recognized units are given in the discussion that follows.

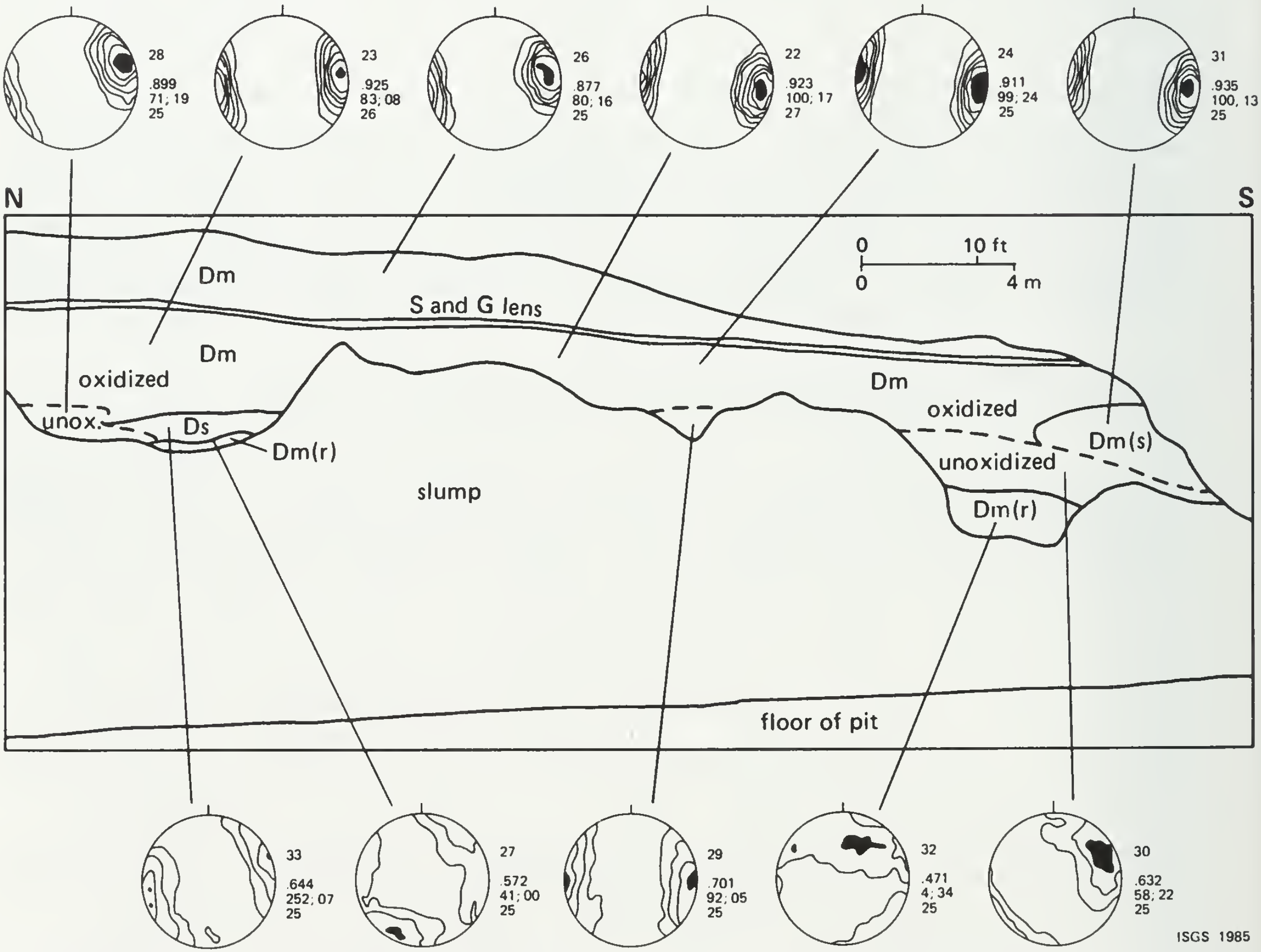


FIGURE 20. Sketch of Haeger Till Member along an east face at Beverly pit. (For explanation of fabric and symbols, see fig. 23.)

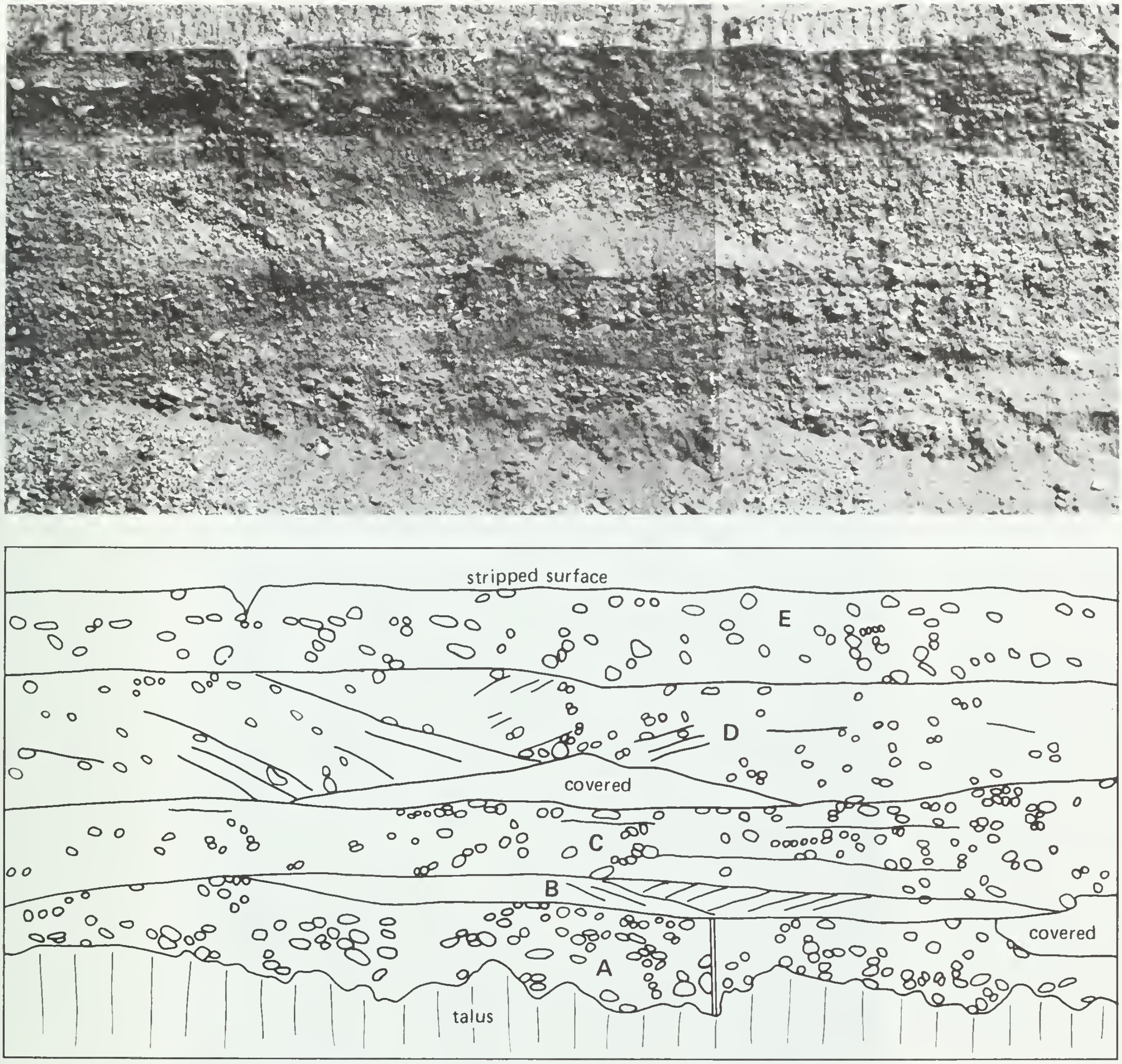


FIGURE 21. Crude horizontal bedding in massive gravel lithofacies (Gmh) of Haeger Till Member, exposed in north face of Beverly pit, September 1984. Crude horizontal beds A, B, C, D, and E and poorly defined, simple cross-beds are outlined in sketch. Horizontal alignment, inclination (of disc-shaped clasts), and podlike concentrations of cobbles and boulders within crude horizontal beds are also illustrated. Scale is 137 cm long.

YORKVILLE TILL MEMBER

Gray, silty clay diamicton (fig. 23) is encountered at the base of the gravel deposit that is being excavated from below groundwater level in the Beverly pit. The matrix of a sample of dark gray (5Y 4/1) diamicton dredged from the base of the pit contained 13% sand, 44% silt, and 43% clay, and in two samples analyzed illite was the most abundant clay mineral, accounting for 75% and 76% of the < 2-µm fraction. This diamicton is probably correlative with diamicton of the Yorkville Till Member mapped at the surface several miles to the west

FIGURE 22. Gravel lithofacies (Gmh) of Haeger Till Member exposed in northeastern part of Beverly pit, September 1984. Sheetwash over pit face has washed finer gravel and sand from around larger cobbles, greatly enhancing their visibility. Disc-shaped clasts dipping to the northeast (up-current direction) indicate that flow was to southwest (to right in photo). Scale is divided into 1-in (2.5-cm) and 6-in (15-cm) segments.

across the Fox River north of Elgin. Yorkville Till Member is mapped in the Huntley and Barlina Moraines northwest of Elgin in Mc Henry County (fig. 4); silty clay diamicton is encountered in water wells beneath Haeger sand and gravel along the West Chicago Moraine in Mc Henry County. Water wells east of the Beverly pit also show silty clay diamicton below loam diamicton and sand and gravel interpreted as Haeger.

HAEGER TILL MEMBER

Description

Gravel lithofacies. Up to 18 m of gravel (Gmh) is present above the Yorkville diamicton in the Beverly pit (fig. 23). The lower 12 m of the unit is below the water table. Material brought up by the dragline is somewhat finer grained and better sorted than the upper 6 m, and a general coarsening upward succession is indicated. The pit operator reported that a discontinuous layer of large boulders is present at the base of the gravel lithofacies.

The color of the gravel is somewhat variable because of its multicomponent nature; however, the overall color of the exposed face is pale yellowish brown and material from under the water is similar but less oxidized (light brownish gray). Gravel from pits in the area consists of about 75% dolomite, 5% chert, 10% other sedimentary rocks, and about 10% metamorphic and igneous rocks. The pit operator has reported finding a few cobble-size pieces of native copper in the eastern part of the pit.

The grain size of the material in the exposed face (figs. 21, 22) is estimated to be about 80% gravel, 18% sand, and 2% silt; trace amounts of clay are present. The face consists predominantly of poorly defined horizontal beds, usually 0.5 to 2 m thick, of pebble-supported cobble gravel. Boulders are locally abundant in these beds. Relatively indistinct conformable contacts between beds are characterized by changes in grain size or discontinuous laminations of poorly sorted, finer grained sediment. Some clast-supported beds have a matrix of finer grained material (closed framework) and others have no matrix (open framework). Most beds are heterogeneous mixtures of a wide range of gravel-size particles (granules to boulders). Locally, thinner beds or lenses of closely sized, fine gravel particles are present. They are usually less than 0.3 m thick and 10 m long. Indistinct, low- to high-angle, simple cross-beds are present either within a single cross-bedding unit or in several cross-cutting units (e.g., in bed B, fig. 21). Indistinct cross-beds also were observed in the other more coarse-grained beds.

Disc-shaped pebbles and boulders lying in imbricate position are present but are not abundant in the gravel lithofacies; it is rare to find two adjacent pebbles in an imbricate orientation. Measurements have not been made, but a general dip toward the northeast was observed. Figure 22 shows disc-shaped clasts with a predominant dip to the northeast. No predominant direction of cross-bed dip was obvious. Although no pronounced fining of grain size was observed in any direction along the exposed face, the horizontal bedding does become thinner and more distinct to the west. In a neighboring pit located about 1 km to the west, more sand and distinctly finer gravel are present.

Diamicton lithofacies. Up to 6 m of diamicton is present above the gravel in the eastern part of the Beverly pit (fig. 23). The diamicton is calcareous, and dolomite is the dominant coarse clast lithology. The lower 1 to 2 m of

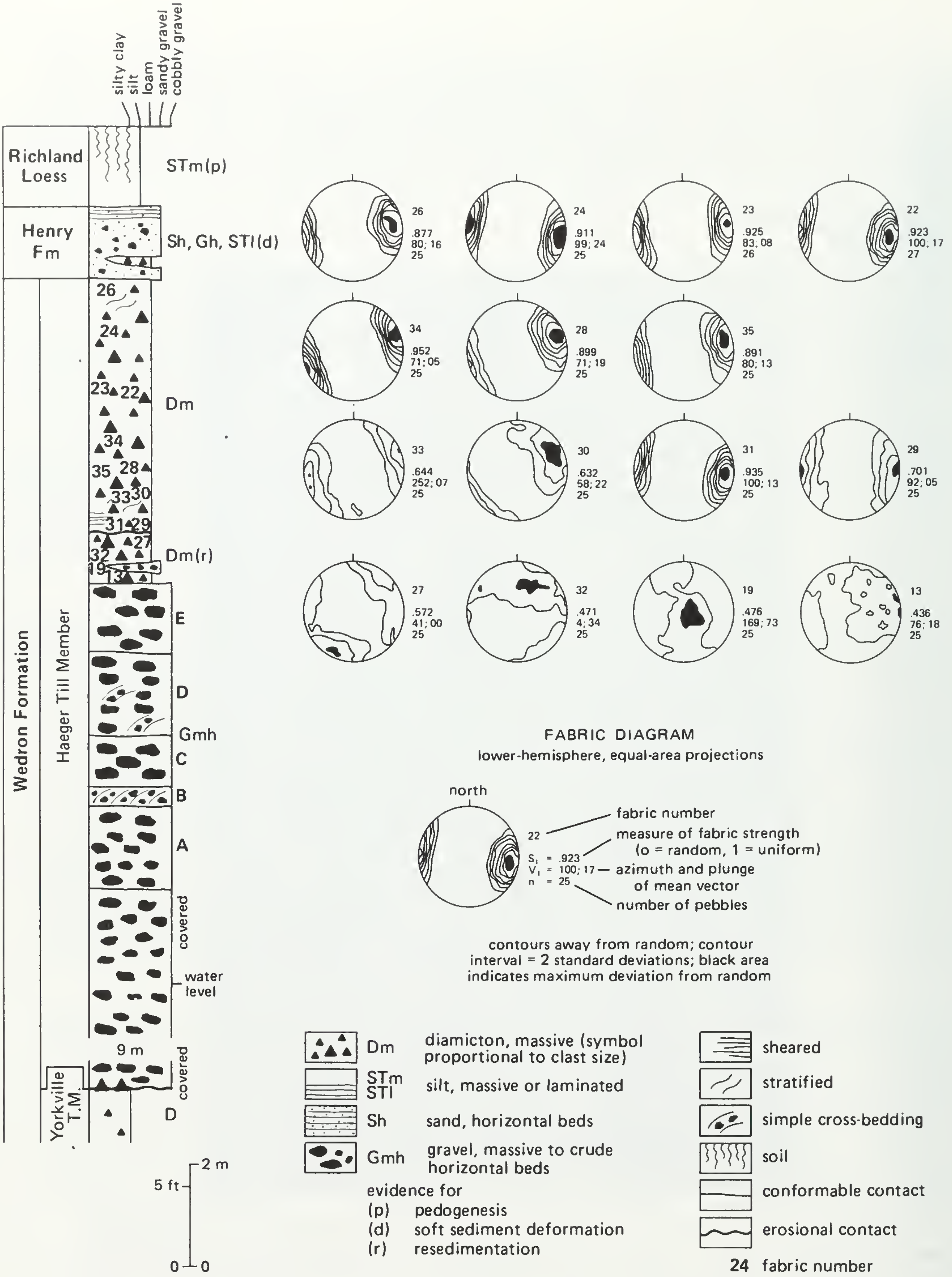


FIGURE 23. Composite section, lithofacies, descriptions, and pebble fabrics at Beverly pit. Letters A, B, C, D, and E indicate beds shown in figure 21. Genetic interpretations of lithofacies are indicated in parentheses after descriptions. All fabrics are based on prolate-shaped pebbles, except fabrics 13 and 19 for which disc- and blade-shaped pebbles were also measured.

STm(p)	silt loam; 10YR 4/4; Modern Soil developed in top 0-1.5m (loess).
Sh, Gh, STl(d)	sand, with gravel and silt; 10YR 5/4; lenticular bodies of diamicton present locally; calcareous, 0-2.5m. (outwash, lake and sediment flow deposits)
Dm	pebbly loam, ranges to sandy loam and silt loam, gravel fraction dominantly dolomite; 10YR 5/1, upper 4 to 5m oxidized to 10YR 5/4; contains lenses of sorted sediment, locally stratified with diffuse grain size and color lamination (Ds), locally fissile with evidence of shearing (Dm(s)); calcareous, 0-6.5 m. (till)
Dm(r)	pebbly loam, ranges to sandy loam and silt loam, gravel fraction dominantly dolomite; 10YR 5/1 to 2.5Y 4/2; contains zones of greater clast concentration, rafts of fine textured laminae, silt stringers and lenses and interbeds of massive or crudely bedded gravel; calcareous, 0-2.0m. (sediment flow deposits)
Gmh	cobbles to boulders, with less than 20% sand or finer particle sizes; gravel fraction dominantly dolomite (75%), about 10% metamorphic and igneous rocks; pale yellowish brown to light brownish yellow; calcareous, up to 18m. (outwash)
D	pebbly silty clay; 5Y 4/1; dredged from floor of pit, crane operators report boulder lag at upper contact; calcareous.

TABLE 6. Grain size and clay mineral data[1] for the Beverly pit.

Stratigraphic unit	Lithofacies	Genetic interpretation		% gvl[2]	Grain size matrix[3] % Sd	% Si	% C	Clay mineral composition[4] % E	% I	% K+C	Sample number
Richland Loess	STm(p)	Loess		0	11	63	26	73	20	7	5-84-14
								60	31	9	7-84-6
Henry Formation		Outwash						36	52	12	5-84-13
								41	47	12	7-84-5
								*19	66	15	7-84-9
Haeger Till Member	Dm	Till		39	44	41	15	*25	66	9	5-84-12
				19	38	48	14	*11	72	17	11-84-8
				26	31	52	17	*12	69	19	11-84-9
				23	53	39	8	*14	67	19	11-84-10
				22	52	39	9	*13	71	16	11-84-11
				41	49	42	9	*15	68	17	11-84-12
				19	42	49	9	*19	66	15	11-84-13
				18	43	50	7	*13	61	26	11-84-14
				16	41	51	8	*18	64	18	9-84-29
				15	46	48	6	*19	63	18	9-84-30
				17	48	39	13	*15	66	20	11-84-15
				12	42	51	7	*20	64	16	11-84-21
				32	39	53	8	*17	61	22	11-84-16
				16	41	45	14	*18	67	15	11-84-17
				13	41	51	7	15	68	17	11-84-18
				15	44	51	5	17	66	17	11-84-19
			$\bar{x}$	21	43	47	10	*17	66	17	clay mineral zone 1 (upper)
			σ	9	5	5	4	4	3	4	
					n = 16			n = 15 (oxidized)			
				27	40	45	15	*11	81	8	5-84-11
				27	37	47	16	* 9	81	10	5-84-10
				13	34	42	24	* 9	81	10	5-84-9
				10	32	50	18	* 8	82	10	5-84-8
								* 8	78	14	7-84-3
				27	31	54	15	*11	78	11	7-84-4
				19	31	53	16				9-84-26
				5	29	55	16				9-84-28
				35	16	65	18	*11	80	9	11-84-26
				15	33	46	21	*12	81	6	11-84-27
				16	30	49	21	* 8	84	8	11-84-28
				26	27	51	22	8	76	16	11-84-29
			$\bar{x}$	20	31	51	18	*10	80	10	clay mineral zone 2 (lower)
			σ	9	6	6	3	3	2	2	
					n = 11			n = 9 (oxidized)			
			$\bar{x}$	21	38	49	13				
			σ	9	6	6	5				all samples
					n = 27						
	Dm(r)	Sediment flow deposits		31	49	39	12	19	63	18	9-84-31
				21	50	37	14	14	64	22	11-84-22
				35	54	35	11	16	65	19	11-84-23
			Average	29	51	37	12	16	64	20	11-84-23
			Range	21-35;	49-54,	35-39,	11-14	14-19,	63-65,	18-22	clay mineral zone 1
					n = 3			n = 3 (unoxidized)			

TABLE 6. *Continued*

Stratigraphic unit	Lithofacies	Genetic interpretation	% gvl[2]	Grain size matrix[3] % Sd	% Si	% C	Clay mineral composition[4] % E	% I	% K+C	Sample number
	Dm(r)	Sediment flow deposits (cont.)	5	15	62	23	7	80	13	5-84-15
			17	23	57	20	8	77	15	5-84-7
			4	17	60	23	5	78	17	5-84-6
			17	24	53	23	*11	79	10	7-84-7
			10	21	58	21	6	80	14	7-84-8
			13	33	48	19	8	77	15	11-84-30
			16	39	36	25	8	76	16	11-84-24
		Average	16	25	53	22	8	78	14	clay mineral zone 2
		Range	4-17;	15-39,	36-62,	19-25	5-11,	76-80,	10-17	
				n = 7			n = 7 (unoxidized)			
		$\bar{x}$	17	33	48	19				
		σ	10	15	11	5				all samples
				n = 10						
	Gmh	Outwash					*15	70	15	JMM-1
							*10	79	11	JMM-2
							*19	71	10	JMM-3
Yorkville Till Member	D	?					4	75	21	11-84-20
			7	13	44	43	6	76	18	5-84-16

[1] Data are tabulated by lithofacies and clay mineral zones within lithofacies. Samples are from several sites exposed in the pit June through December, 1984.

[2] Percent of whole sample

[3] Percent of < 2-mm fraction

[4] Percent of < 2-µm fraction

*Oxidized sample or average

diamicton (Dm(r)) is gray (10YR 5/1) and less uniform than the main part of the unit (Dm), much of which is oxidized and massive. The matrix (< 2-mm fraction) of the lower diamicton facies is quite variable in texture, averaging 33% sand, 48% silt, and 19% clay in 10 samples analyzed with standard deviations of 15%, 11%, and 5%, respectively. Two distinct clay mineral compositions are present in the < 2-µm fraction of relatively unoxidized samples. One composition (based on 3 samples) averaged 16% expandables, 64% illite, and 20% kaolinite plus chlorite, with ranges of 14 to 19%, 63 to 65%, and 18 to 22%, respectively; the other composition (based on 7 samples) averaged 8% expandables, 78% illite, and 14% kaolinite plus chlorite, with ranges of 5 to 11%, 76 to 80%, and 10 to 17%, respectively (table 6). The two clay mineral compositions of this lithofacies are present in the exposure shown in figure 20, where in the vicinity of fabric 32 diamicton containing less illite overlies diamicton containing more illite. The unit is characterized by pods and discontinuous lenses of sand and gravel, rafts of fine-textured laminae (fig. 24), silt stringers, zones of coarse clast concentration (fig. 25), and pebble fabrics that are weak or lack a preferred orientation parallel to the inferred regional ice flow direction (fig. 23). The lower contact is undulating, but generally comformable.

Most of the overlying loam diamicton lithofacies (Dm) is oxidized to yellowish brown (10YR 5/4), although locally the lowermost 1 m is gray (10YR 5/1). The oxidation boundary is irregular, but fairly abrupt. The same two clay mineral

FIGURE 24. Raft of fine sediment in massive diamicton of Dm(r) (sediment flow deposits) lithofacies of Haeger Till Member at Beverly pit. Pick is 44 cm long.

FIGURE 25. Zones of coarse clast concentration in massive diamicton of Dm(r) (sediment flow deposits) lithofacies of Haeger Till Member at Beverly pit. Pick is 44 cm long.

compositions present in the underlying diamicton lithofacies are present in this lithofacies (27 samples analyzed). Locally, diamicton containing less illite overlies diamicton containing more illite. Two unoxidized samples of one composition contained 66% and 68% illite; an unoxidized sample of the other composition contained 76% illite (table 6). The boundary between these clay mineral compositions (or zones) is abrupt and does not coincide with oxidation boundaries or any observed stratigraphic breaks. Where this lithofacies contains more illite, it overlies the clay mineral zone in the lower lithofacies containing more illite; where the lithofacies contains less illite, it overlies the zone in the lower lithofacies containing less illite. The matrix in 27 samples analyzed for grain size averaged 38% sand, 49% silt, and 13% clay with standard deviations of 8%, 5%, and 5%, respectively. The matrix of samples from the clay mineral zone containing more illite is generally finer than that of the clay mineral zone containing less illite; it averaged 12% less sand and 8% more clay; however, overlap in texture between the two zones does occur (table 6). Lenses of sorted sediment are present in the diamicton and in some places are continuous for tens of meters (fig. 20). Locally, massive diamicton grades to stratified diamicton. Layers of sorted sediment drape over and under coarse clasts (fig. 26). Near the base, the unit is more compact and locally exhibits fissility, an erosional lower contact, and evidence of bedding plane shears.

The mean vector of the eight strongest pebble fabrics has an azimuth of 86° and a plunge of 13°. Near the base of the unit, pebble fabrics show a similar, though weaker, long axis orientation (fabrics 29, 30, 33, figs. 20, 23). All 11 pebble fabrics measured indicate a significant preferred orientation of prolate pebbles (fig. 23) parallel to the inferred regional ice flow direction. Ice flow from the east is inferred from the north-south-trending crest of the West Chicago Moraine in this area (map, back cover) and from azimuths of striae on bullet-shaped boulders ranging between 74° and 112°. With the exception of fabric 33 in stratified diamicton, which has an average pebble plunge 7° in the down-ice direction, the pebble fabrics measured have an average pebble plunge 14° up-ice (to the east).

Interpretation

The gravel lithofacies exposed at the Beverly pit is part of a complex of coalescing outwash fans up to 10 km wide that parallels the front of the West Chicago Moraine for 38 km in Mc Henry, Kane, and northern Cook Counties (Masters, 1978). Cobb and Fraser (1981) and Fraser and Cobb (1982) described four sediment assemblages (marginal, proximal, medial, and distal) in a portion of this outwash complex adjacent to the West Chicago Moraine in Mc Henry County. They found that the proglacial deposit generally coarsens and thickens eastward toward the front of the West Chicago Moraine. A prograding system was interpreted; encroachment of the ice margin from the east spread coarse cobble gravel of the proximal assemblage over finer sorted sediment (gravel, sand, silt and clay) of the medial and distal assemblages. Muddy cobble gravels (matrix-supported) of the marginal assemblage adjacent to the West Chicago Moraine were interpreted as mudflow deposits originating from mass gravity movements of material that had melted out at the surface of the Haeger ice to the east. Cobb and Fraser (1981) and Fraser and Cobb (1982) did not recognize till in the marginal assemblage in the area they studied in Mc Henry County.

Gravel lithofacies. The gravel lithofacies (Gmh) at the Beverly pit is equivalent to Miall's (1977) Gm facies, defined as massive or crudely bedded gravel. The deposit, which coarsens upward from a fine cobble gravel to a coarse cobble gravel, is interpreted as proglacial fluvial sediment that was deposited in a prograding outwash plain complex adjacent to the advancing Haeger ice margin. The coarse cobble gravel exposed at the Beverly pit is similar to the proximal assemblage in the outwash complex described by Cobb and Fraser (1981) and Fraser and Cobb (1982) in Mc Henry County.

The available indicators of the direction of sediment transport and deposition imply that glacial meltwater was flowing to the southwest. The presence of large boulders at the base of the gravel indicates that at this site there was probably a very strong erosional event that removed part of the underlying Yorkville Till Member before gravel deposition began. At other locations (Cobb and Fraser, 1981; Fraser and Cobb, 1982) the base of this sand and

FIGURE 26. Sorted sediment draped around coarse clasts in stratified diamicton interpreted as meltout till of Haeger Till Member at Beverly pit. Knife handle is 10 cm long.

gravel complex is underlain by silt and clay, indicating that as the Haeger ice margin advanced, local ponding of meltwater occurred prior to the establishment of proglacial meltwater channels.

The general northeast dip of disc-shaped cobbles in massive beds (A, C, and E, fig. 21) indicates an upcurrent direction to the northeast. The coarse material in these beds suggests rapid deposition with little or no sorting, probably by high energy meltwater that carried the finer sand, silt, and clay particles farther downstream. These beds may represent transverse cross-sections of the cores of longitudinal bars in a broad complex of braided channels. The finer cobbles and sand in bed B, which contains two indistinct sets of cross-beds, were probably deposited in a channel between longitudinal bars. The indistinct, simple cross-beds in the predominantly massive bed D may reflect southward prograding deposition on the flanks of two longitudinal bars, with the bar to the east eventually prograding over the bar to the west.

Diamicton lithofacies. Lithofacies variability between the diamicton units described at the Beverly pit reflects different depositional environments. Many of the sedimentary properties of the lower lithofacies (Dm(r)) are among those Lawson and Kemmis (1983) and Eyles and others (1983) described as characteristic of sediment flow deposits. The sediment assemblage is similar to the marginal assemblage Cobb and Fraser (1981) and Fraser and Cobb (1982) described in Mc Henry County. They interpreted the muddy cobble gravel of the marginal assemblage along the West Chicago Moraine as mudflow deposits originating in the Haeger ice-marginal environment. A similar origin is suggested for the lower diamicton lithofacies at the Beverly pit.

During the time the Haeger ice margin was located immediately east of the Beverly pit, some of the debris that had melted out in the supraglacial environment probably was mobilized by mass gravity processes and redeposited in the proglacial environment. Such processes could produce many of the sedimentary features observed in the lower diamicton lithofacies, including interbeds of sand and gravel, rafts of fine-textured laminae, silt stringers, coarse clast concentrations along bed boundaries, plugs of pebble-to-cobble-size gravel enclosed by diamicton, pods of sand and fine gravel, and strata of variable texture. The lack of a preferred orientation in pebble fabrics (fig. 23) is also consistent with an interpretation of sediment flow origin. Many of the sedimentary properties of the lower lithofacies are similar to those described as Type II sediment flows by Lawson (1979).

The overlying diamicton lithofacies (Dm) is interpreted as till. All the pebble fabrics measured in this unit show a significant preferred orientation of prolate pebbles that parallels the direction of regional ice flow during the Haeger ice margin advance. The Haeger ice margin overrode the proglacial gravel and sediment flow deposits in the eastern part of the Beverly pit and deposited till, probably by a combination of meltout and lodgement.

In most of the outcrop area observed, the upper diamicton lithofacies exhibits a suite of sedimentary properties that are most often associated with meltout till. These include non-uniform texture (table 6), lenses of sorted sand and gravel (S,G, fig. 20), diffuse color and grain-size laminations, and sorted layers draped over and under coarse clasts (fig. 26). Lawson (1979) found that strong preferred pebble orientations with up-ice plunges could be preserved in till that melted out from basal zone debris-rich ice. Thick debris-rich layers of ice probably accumulated at the ice margin by shear stacking. Variability in the texture and sorting of debris in the debris-rich ice layers is reflected in the variability observed in the meltout till--for example, vertical and lateral changes in grain size of the matrix (table 6) and the presence of lenses of sand and gravel. The diffuse color and grain-size laminations in stratified portions of the diamicton unit may have been produced by melting out of alternating debris-rich and debris-poor layers. Differential settling of fine-grained particles into pore spaces of underlying layers can produce subtle color and textural laminations (Lawson, 1981). Drapes of fine-grained sorted sediment over and under coarse clasts can also be explained by differential settlement as the ice melted from alternating layers of variable sorting and debris content. The weaker pebble fabrics associated with the lower part of this unit (fabrics 29, 30, 33, figs. 20, 23) may reflect meltout from basal ice containing less debris.

Basal meltout was probably responsible for most of the accumulation of diamicton in the eastern part of the Beverly pit. However, in the area of fabric 31 (fig. 20) on the east face, the diamicton has characteristics that Lawson and Kemmis (1983), Dreimanis (1976), and Boulton and Paul (1976) have described as indicative of lodgement till. Here the diamicton is overcompacted and fissile and has a strong preferred pebble orientation (as indicated by fabric 31, figs. 20, 23). The diamicton is more massive with little interbedded sorted sediment. Shear planes and an erosional lower contact marked by sand are further evidence that locally some of the diamicton may have been deposited by lodgement.

HENRY FORMATION

Up to 1.5 m of sand and gravel (Sh,Gh) overlies the diamicton lithofacies in the eastern part of the pit. Laminated silt (STl(d)) and fine sand are sometimes present in this lithofacies and in a topographic low to the west they replace the sand and gravel and diamicton. Two (oxidized) samples from the sand and gravel analyzed for clay mineral composition contained 47% and 52% illite. Diamicton beds have been observed in the sand and gravel. The lithofacies is interpreted as representing fluvial, lacustrine, and resedimentation deposits of the supraglacial and proglacial environments at the Haeger ice margin. It is classified as Henry Formation.

RICHLAND LOESS

Massive silt and clayey silt (STm(p)) up to 2 m thick blankets the landscape. The unit contains abundant expandable clay minerals (60% and 73% in two samples analyzed) and though predominantly silt, contains some clay and sand (table 6). The Modern Soil is developed primarily in this unit. The massive silt is interpreted as loess (Richland Loess) that accumulated on the landscape during the late Wisconsinan deglaciation.

DISCUSSION

CLAY MINERAL ZONES IN THE HAEGER TILL MEMBER

The marked difference in clay mineral composition observed within the Haeger at the Beverly pit requires an explanation. In the diamicton lithofacies interpreted to be till, the upper clay mineral zone has about 10% less illite than does the lower zone (table 6). The two distinct compositions are also present in the diamicton lithofacies interpreted as sediment flow deposits.

In the area mapped as Haeger Till Member (Harvard Sublobe) (figs. 3, 4), exposures of unoxidized diamicton are rare. The matrix of Haeger diamicton commonly averages about 63% illite but intensely weathered samples sometimes contain 55% or less illite. Larger percentages of illite (70% or greater) have been measured in subsurface samples from the Joliet Sublobe that we have interpreted as Haeger, however. This is especially true in subsurface samples from east and south of the southern area mapped as Haeger.

Weathering does not appear to account for the two distinct compositions at the Beverly pit. Oxidized samples from till in the zone with less illite averaged 66% illite, nearly identical to the percentage of illite in the two unoxidized samples (67% and 68%). Percentages of expandables and kaolinite plus chlorite were also about the same in oxidized and unoxidized samples (table 6). In contrast, oxidized samples in the zone with more illite appear to contain more illite than unoxidized samples in the same zone (averages of 80% and 76% illite, respectively). The larger illite percentages are the result of a significant decrease in the chlorite peak in oxidized samples, which results in an apparent increase in illite. Thus, the two clay mineral compositions respond differently to weathering and are distinct in unoxidized samples: they must represent real compositional differences in the till deposited.

One possible interpretation is that the two compositions are the result of till deposition during two different glacial events. H. D. Glass (personal communications) believes that the compositions are so different that this is the only viable interpretation and that the diamicton and outwash that contains more illite (about 76%) should not be included in the Haeger Till Member. The sedimentological evidence at the Beverly pit does not support this interpretation, however. The entire succession of deposits appears conformable and uninterrupted. Proglacial outwash gravels and sediment flow deposits are overlain by lodgement and basal meltout till, which is overlain by fluvial and lacustrine sorted sediments and sediment flow deposits. We have observed no evidence for ice margin retreat and readvance within the depositional sequence. The succession is interpreted to represent proglacial sedimentation from an approaching ice margin, glacial sedimentation beneath active and stagnant glacier ice, and supraglacial and proglacial sedimentation from wasting glacier ice.

Morphological evidence is also consistent with an interpretation of a single ice margin advance. The outwash complex in which the Beverly pit is excavated has been interpreted (Masters, 1978) as a continuous band of bouldery outwash that extends for 35 km along the front of the West Chicago Moraine from central Mc Henry County southeastward to northern Du Page County. Sedimentological study in Mc Henry County (Cobb and Fraser, 1981; Fraser and Cobb, 1982) and the present study of the Beverly pit indicate that this outwash complex represents a prograding system associated with the advance of the ice margin that formed the West Chicago Moraine and deposited the Haeger Till.

The location of the Beverly pit with respect to the Harvard and Joliet Sublobe boundaries and the change in the orientation of the West Chicago Moraine may be important in explaining the different compositions in the Haeger Till Member. The Beverly pit is located in the north-south trending segment of the moraine, several kilometers south of where it meets the northwest-southeast trending segment (map, back cover), and about 5 km north of the area where the West Chicago Moraine is mapped as Wadsworth Till Member (fig. 4).

Thus, the Beverly pit is located in a critical area with respect to ice sublobe margins. If the Haeger ice margin were continuous across the Harvard and Joliet Sublobes in a position approximately coincident with the present West Chicago Moraine, ice flow from the two sublobes would have converged in that portion of the ice margin where the two sublobes met (i.e., the area in which the Beverly pit is located). Lake Michigan Lobe ice that advanced into the Harvard Sublobe area occupied a position on the west flank of the Lake Michigan Basin and flowed southwest across southern Wisconsin and northern Illinois. Lake Michigan Lobe ice that advanced into the area of the Joliet Sublobe flowed farther south through the Basin before flowing out of the Basin and extending to the west. Ice with debris from somewhat different source areas could have converged and, depending on flow dynamics between the two sublobes, would stack or interfinger in the area where the sublobes coalesced.

Haeger diamicton containing more than 65% illite has not been found in the northern area of the Harvard Sublobe, either at the surface or in the subsurface. In that area and in southeastern Wisconsin the Haeger Till Member and equivalent New Berlin Formation are underlain by the Tiskilwa, which averages about 63% illite (S. Wickham, 1979; Schneider, 1983). The Tiskilwa Till Member is generally absent in the subsurface of the southern part of the Joliet Sublobe, however (Kempton and Hackett, 1968). Diamictons deposited by the Lake Michigan Lobe in Illinois commonly contain from 70 to 80% illite and that composition has been interpreted as reflecting a Lake Michigan Basin source (Willman, Glass, and Frye, 1963). Thus, Haeger ice of the Joliet Sublobe could easily have entrained debris with these compositions either in the Basin or from more local older glacigenic deposits with abundant illite (e.g., Malden or Yorkville Till), while Haeger ice of the Harvard Sublobe would have been less likely to entrain debris with abundant illite.

The two distinct compositions present in the Haeger at the Beverly pit are interpreted to reflect differences in the composition of debris entrained by sublobes of a glacier whose ice margin extended across the Harvard and Joliet Sublobes. A textural difference also occurs between samples of the two clay mineral zones at the Beverly pit; the matrix texture of till with more illite is generally finer than that of till with less illite (table 6). If debris of different composition were entrained by the two sublobes, a difference in matrix texture of the till deposited by the glacier would not be surprising. The fact that both clay mineral compositions also are present in the proglacial sediment flow deposits is further evidence that ice with debris of different composition must have converged in the area of the Beverly pit.

CORRELATION WITH THE LEMONT DRIFT

In several respects the Haeger Till Member exposed at the Beverly pit is similar to the Lemont drift described by Bogner (1973). Correlation of the two units is supported by the following observations:

- Both units occur stratigraphically below the Wadsworth Till Member. The contact between the Wadsworth and the Lemont was observed at the Lemont type section (Stop 2). Test boring and water well samples indicate that Haeger is present beneath Wadsworth several kilometers east of the Beverly pit.

- Both sediment assemblages represent prograding proglacial-glacial successions. Thick proglacial outwash is associated with both units.

- Both units are present in the West Chicago Moraine, which is characterized by kame and kettle topography along its entire extent in Illinois, in areas mapped as Haeger as well as in areas mapped as Wadsworth. In both the Lemont and the Elgin area exposures in the moraine indicate that the moraine consists of loam diamicton over gravel and sand, even though the moraine is capped by silty clay diamicton of the Wadsworth in the Lemont area.

- The average matrix textures in tills from the two sections are nearly identical. Haeger till averaged 38% sand, 49% silt, and 13% clay (table 6). Lemont till averaged 40% sand, 48% silt, and 12% clay. Greater sand percentages are reported for the Haeger farther north. S. Wickham (1979) reported an average of 45% sand in 32 samples of Haeger Till and Schneider (1983) reported an average of 58% sand in 15 samples of New Berlin till from Wisconsin. Considering the vertical variability in matrix texture in Haeger diamicton at the Beverly pit, lateral variability in diamicton texture within the Haeger Till Member is not surprising.

- Dolomite is by far the most abundant coarse clast in both deposits and the matrix of both units is highly dolomitic.

- Although Lemont diamicton generally contains more illite (about 75%, this report) than does Haeger diamicton--for which averages of 62% (S. Wickham, 1979) and 63% (Schneider, 1983) have been reported--Haeger containing more illite (76% or greater) is present at the Beverly pit. The latter composition, as well as that of the Lemont, is interpreted to reflect a Lake Michigan Basin source and deposition by the Joliet Sublobe.

Thus, lithologic and sedimentological similarities exist between the Haeger Till Member and the Lemont drift, and correlation of the two units seems probable. If the Haeger ice were continuous across the Harvard and Joliet Sublobes and if the West Chicago Moraine in the Joliet Sublobe represents the buried moraine of the Haeger ice margin, stratigraphic tracing of the Haeger Till Member to the Lemont type area should be possible. Preliminary subsurface work indicates that loam diamicton and sand and gravel are present beneath clayey diamicton as far south as West Chicago, which is located approximately halfway between the two localities.

Spatial relationships and stratigraphy in the Elgin area where the Harvard and Joliet Sublobes meet indicate that the Haeger lies stratigraphically between silty clay diamictons mapped as Yorkville and Wadsworth. Stratigraphic differentiation of the fine-grained diamictons south of the Elgin area will be necessary to determine if they are mapped correctly and what their relationship is to other Wedron units (i.e., Malden and Lemont) in the critical area of the Fox River valley south of Elgin.

REVISION OF VALPARAISO MORAINIC SYSTEM

Regardless of whether or not the Haeger and Lemont correlate, the Valparaiso Morainic System represents different glacial events in the Harvard and Joliet Sublobes (map, back cover; fig. 3). In the Harvard Sublobe the West Chicago Moraine formed during the Haeger ice margin advance. The Haeger Till Member (fig. 4) was deposited during that event. In the Joliet Sublobe deposition of the Wadsworth Till Member (fig. 4) that caps the west Chicago Moraine took place during the later Wadsworth phase, even though the morphology of the West Chicago Moraine may have been inherited from the earlier Haeger glacial phase. Using the same name for the ice margin position of separate glacial phases during which distinct glacigenic deposits in stratigraphic position were produced is confusing and misleading. Because West Chicago is located in the Joliet Sublobe, which is mapped as Wadsworth, the name West Chicago Moraine takes precedence there and the names West Chicago Moraine and Valparaiso Morainic System should be discontinued in the Harvard Sublobe. It is here suggested that that part of the moraine in the Harvard Sublobe be named Woodstock, taken from the village of Woodstock in Mc Henry County, where morainic topography is typically developed. North of the Elgin area, where end moraine morphology is indistinct, the front of the Valparaiso Morainic System should be coincident with the mapped western extent of the Wadsworth Till Member, which lies east of the Chain O' Lakes lowland in Lake County (Hansel and Glass, 1983). Such a change would eliminate a 32-km offset of the Valparaiso Morainic System front at the Illinois-Wisconsin state line (Schneider, 1983), and would correspond to the original concept of the "Valparaiso Moraine" as described by Chamberlin (1882) and Leverett (1899).

EPILOGUE

W. Hilton Johnson and Ardith K. Hansel

Early interpretations of the glacial history of northeastern Illinois placed strong emphasis on interpretations of the geomorphology of the area. Integration of some geomorphic observations with stratigraphic and sedimentological data described at field trip stops 2 and 3 suggests an alternative hypothesis that explains many of the conflicting interpretations and appears compatible with most existing data and observations. It has not been adequately tested but is presented for consideration.

GEOMORPHIC CONSIDERATIONS

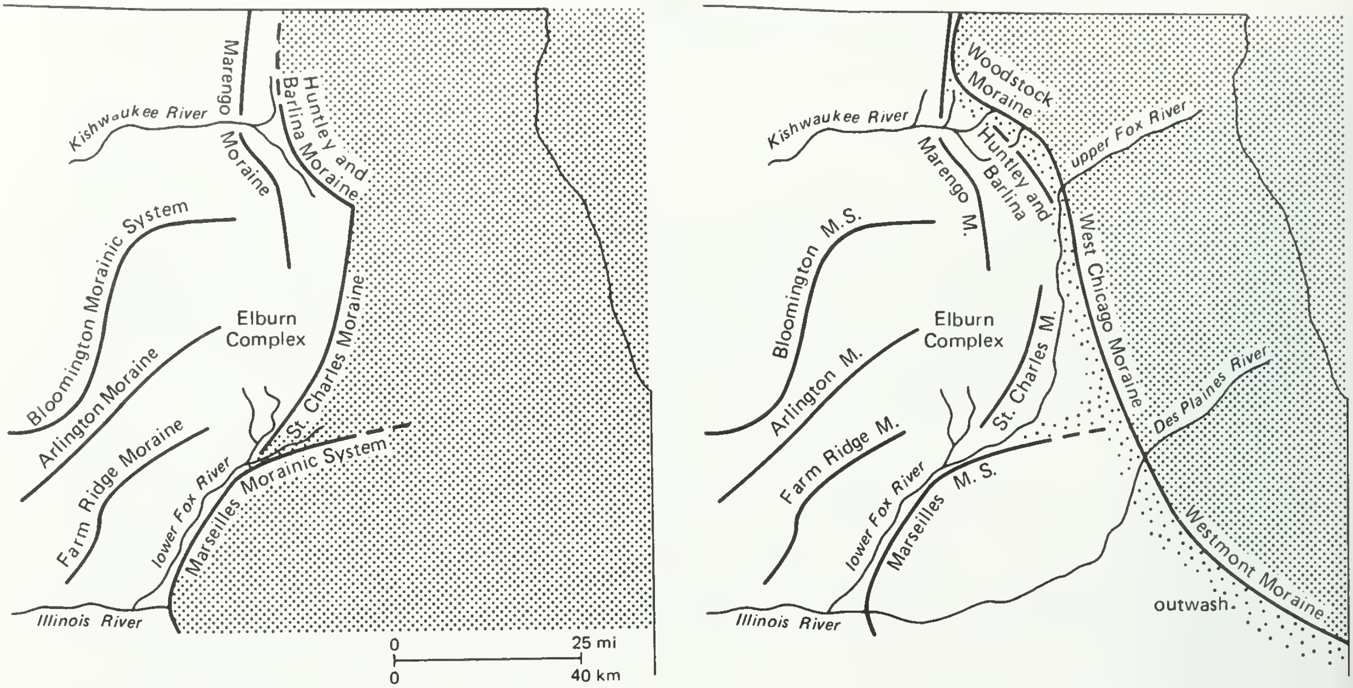
Our hypothesis is based in part on the following geomorphic observations:

- Morphologically, the West Chicago Moraine (and the Woodstock Moraine, formerly mapped as the West Chicago) appears continuous from the Indiana state line to the Wisconsin state line. It has been mapped as a continuous end moraine by Willman and Frye (1970), Leighton and Brophy (1961), and Ekblaw (1941). As mentioned in the Stop 3 discussion, complications arise because in the Harvard Sublobe, Haeger Till is the surface drift whereas in the Joliet Sublobe, Wadsworth Till is the surface drift (figs. 3, 4). Thus, although the end moraine appears continuous morphologically, it does not share the same history in the two sublobes.

- The Wadsworth Till Member boundary north of the area of overlap is morphologically indistinct (i.e., the morphology of the Haeger drift plain to the west is generally similar to that of the Wadsworth drift plain to the east). Thus, the Wadsworth advance did not result in any distinct ice-marginal landforms in this area.

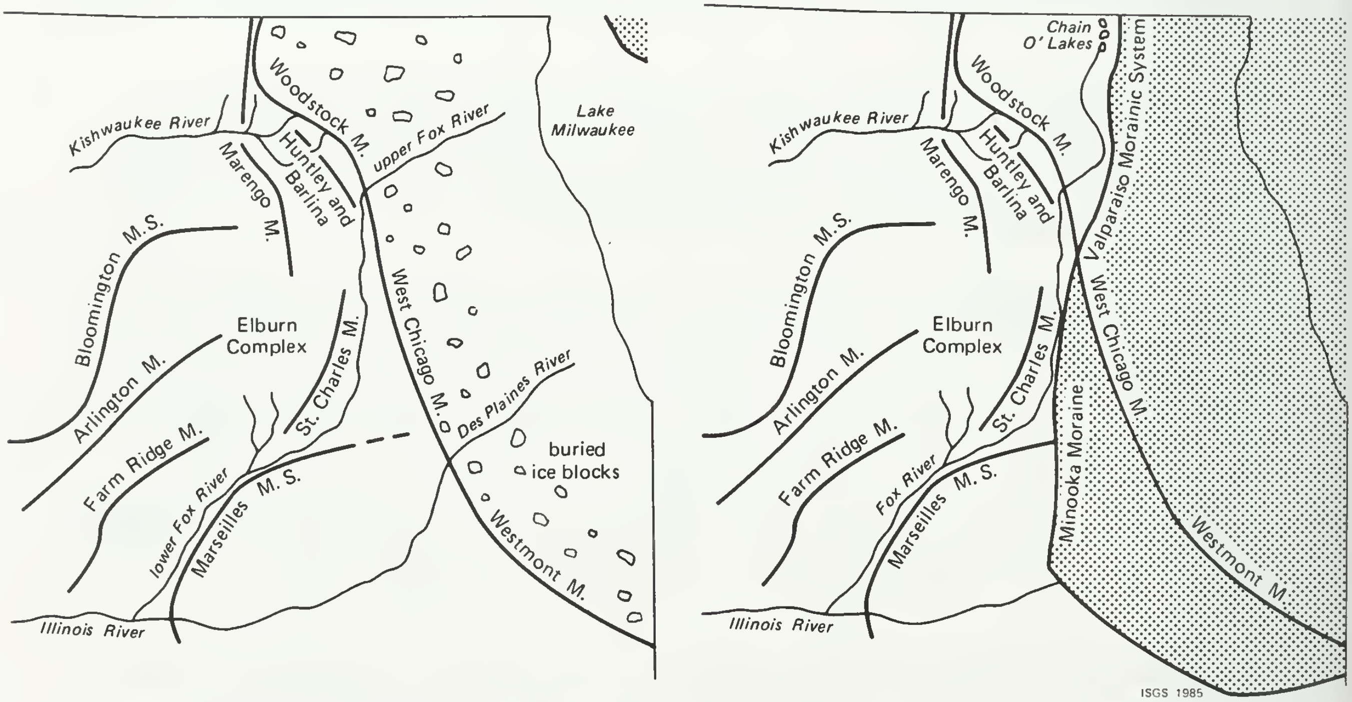
- Bretz (1939, 1955), Powers and Ekblaw (1940), Rosenshein (1962), and Schneider (1983) have reported that locally the Valparaiso Drift (Wadsworth Till in Illinois, extending into Indiana; Oak Creek Formation in Wisconsin) is thin and that much of the surface topography is a reflection of a buried land surface developed on older drift (Haeger Till and Lemont drift in Illinois; New Berlin Formation in Wisconsin). Schneider (1983) interpreted the Valparaiso topography in southern Wisconsin to be the result of deposition from an ice sheet that overrode large areas containing stagnant ice remnants from the earlier ice sheet, which resulted in deposition of the New Berlin (Haeger) till.

- The Minooka Moraine (mapped as Yorkville Till) and the restricted Valparaiso Morainic System (mapped as Wadsworth Till) have north-south orientations at about the same longitude, and the slight offset in longitude is located near the termination of the Minooka Moraine and the overlap of Haeger Till by the Wadsworth Till (map, back cover; fig. 4). The Minooka Moraine has been interpreted as being overlapped by the Haeger Till Member that composes the Woodstock Moraine. Because of



a. Ice margin stabilized at Huntley, Barlina, and St. Charles Moraines and Marseilles Morainic System. Deposition of Yorkville Till Member.

b. Ice margin advance to Woodstock, West Chicago, and Westmont Moraines. Deposition of Haeger Till Member and Lemont drift.



c. Active ice margin in Lake Michigan Basin, formation of proglacial Lake Milwaukee, and areas of stagnant ice near former ice margin position.

d. Ice margin advance to northern part of Valparaiso Morainic System and Minooka Moraine. Deposition of Wadsworth Till Member.

FIGURE 27. Hypothesized sequence of late glacial events in northeastern Illinois.

erosion related to the Fox River, the well-developed Minooka ridge to the south becomes discontinuous in this area, creating difficulties in mapping the Minooka Moraine. Several different morphologic interpretations are possible.

- The topography of the Minooka Moraine and other younger moraines (Rockdale, Wilton Center, Manhattan) composed of Yorkville Till is distinct from that developed on the Wadsworth Till of the Valparaiso Morainic System. The former moraines have relatively gentle and smooth slopes and very few kettles; those in the Valparaiso Morainic System have steeper and more irregular slopes of ice-contact origin, and kettles are more abundant.

- The Fox River valley geomorphically is complex and different portions of it appear to have developed at different times. Leighton's (1925) observation that morainic topography of the West Chicago and Minooka Moraines extends down into the valley must be considered.

THE HYPOTHESIS

Our hypothesis is based on the strong evidence for correlation of Haeger Till Member with the Lemont drift, the occurrence of outwash buried by fine-grained diamicton along the West Branch of the Du Page River, correlation of the Lemont outwash with outwash in the Kankakee Valley in Indiana, and the geomorphic relationships described previously. According to this hypothesis, south of the Harvard Sublobe the Haeger Till and Lemont drift would be stratigraphically within deposits currently mapped as Yorkville and Wadsworth, and the Wadsworth Till Member would extend beyond the margin of the West Chicago Moraine in the Princeton and Joliet Sublobes. The following sequence of events is suggested:

1. The ice margin stabilized, after one or more advances, at positions marked by the St. Charles, Huntley, and Barlina Moraines and the Marseilles Morainic System (fig. 27a). The Yorkville Till Member was deposited, and the lower Fox River was established as an ice-marginal drainage system. The ice margin eventually withdrew to an unknown position, possibly somewhere near the current margin of Lake Michigan. An extensive proglacial lake probably formed along the ice margin.

2. The ice margin readvanced to a position approximately coincident with the Woodstock and West Chicago Moraines to the west and the Westmont Moraine (?) to the south (fig. 27b). An extensive proglacial outwash sheet was deposited during the advance and a broad outwash plain formed around the ice margin from Wisconsin into Indiana. In Illinois, ice marginal drainage was southward down the general area of the modern West Branch of the Du Page River to the point where it was deflected by the Marseilles Morainic System and joined the lower Fox River. Haeger and Lemont outwash and outwash in the Kankakee Valley were deposited at this time.

3. When the ice margin was at its maximum position, the following events probably occurred: (1) the outer fringe of the ice sheet developed a cold base; (2) subglacial waters built up back from the margin, possibly in the Lake Michigan Basin; and (3) the upper Fox River and Des Plaines River valleys were initially developed by sudden release of the stored waters via tunnel valleys. These rivers were in an erosive regime and

relatively deep valleys were eroded through the proglacial Haeger-Lemont outwash. The Fox River was established in its modern course somewhat west of the outwash plain (fig. 27b).

4. As the basal ice warmed, Haeger and Lemont till were deposited by meltout from stagnant ice. The active ice margin retreated some distance into the Lake Michigan Basin but large areas of stagnant ice remained and much supraglacial sedimentation took place in the upland area west of the Basin (fig. 27c). Debris was let down and morainic topography developed on the flanks of the Fox River valley in the area of the Woodstock Moraine. Lake Milwaukee formed as a proglacial lake in the southern Lake Michigan Basin.

5. Ice margin advance occurred, lacustrine silt and clay in the Lake Michigan Basin was eroded by the ice sheet, and the ice sheet overrode previously deposited drift that locally still contained relatively large blocks of buried ice. Wadsworth till and outwash were deposited during this event. This advance terminated near the Wadsworth Till margin (Valparaiso Morainic System) north of where it overlaps Haeger Till (fig. 27d). The upper Fox River south of the Chain O' Lakes became established in an ice-marginal position in this area. South of the Harvard Sublobe, the ice margin extended beyond the buried Haeger and Lemont till margins, probably to a position marked by the Minooka Moraine. In the latter area the ice sheet overrode the Haeger-Lemont outwash plain. Thus the resulting morphology of the Wadsworth drift plain in this general area is significantly different from that found where Wadsworth was deposited over Haeger and Lemont till with blocks of stagnant ice. The buried outwash west of the West Chicago Moraine would correspond to the outwash reported by Fisher (1925) and Kemmis (1978) and mapped by Kempton and others (1977).

6. Following this ice margin advance and subsequent ice margin retreats and readvances, several end moraines may have formed, including the Rockdale, Wilton Center, and Manhattan Moraines, moraines of the Valparaiso Morainic System, the Tinley Moraine, and moraines of the Lake Border Morainic System. The West Chicago Moraine by and large represents a palimpsest moraine in the area where it is buried by Wadsworth Till, but locally it may be a superposed end moraine. Fine-grained diamicton of the Wadsworth, some of which currently is mapped as Yorkville, was deposited. Timing of this glacial phase is provided by radiocarbon dates of mammoth bone (13, 130 ± 350 RCYBP, ISGS 498) and peat (15,240 ± 120 RCYBP, ISGS 465) that occur in clay above outwash at the distal margin of the West Chicago Moraine (Springer and Flemal, 1981). The peat date is considered more reliable and gives a minimum age for the Wadsworth in the West Chicago Moraine.

Testing of the hypothesis will depend on stratigraphic differentiation of the fine-grained diamictons. A critical question is, does Wadsworth Till extend west beyond the West Chicago Moraine south of Elgin and correlate with diamicton making up the Minooka Moraine (or other diamicton currently mapped as Yorkville)? Investigations of outwash stratigraphy and sedimentology in the subsurface and at the surface will play a major role. Along the Du Page and Fox River valleys it will be critical to distinguish older exhumed outwash from outwash that is younger and not exhumed.

The hypothesis agrees with some of the interpretations of the early workers, but conflicts with others; it again puts emphasis on the Minooka Moraine, the old "early" Wisconsin-"late" Wisconsin (Leverett, 1899) or Cary-Tazewell (Leighton, 1933, 1960) boundary. A major change, however, has the Minooka Moraine younger rather than older than the palimpsest and superposed West Chicago Moraine. It recognizes the importance of the Fox River valley, but again its origin and time of formation varies from earlier interpretations. The West Chicago Moraine is retained as an important geomorphic feature and the importance of inheritance of topography from an earlier ice advance (Bretz, 1939) is given even greater emphasis. It also agrees with Bretz's (1955) suggested correlation of Lemont gravels with gravel (Haeger-related) near Algonquin.

The hypothesis raises questions with regard to the timing and origin of the Kankakee Flood that is considered to be contemporaneous with formation of the Valparaiso Morainic System and deposition of the Wadsworth Till Member (Ekblaw and Athy, 1925; Willman and Frye, 1970). Although the main Kankakee event may be younger, large quantities of meltwater must have been discharged during the Haeger-Lemont glacial phase, as suggested by the abundance of outwash deposited during the advance and the valleys that were eroded subsequently. It appears likely that a series of floodlike events occurred, and that a series of large glacial lakes probably formed in response to ice margin fluctuations and these "flood" events.

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ROAD LOG

Leon R. Follmer and Ardith K. Hansel

0.0 Assemble at west entrance (Carroll Avenue side) of the Holmes Student Center at Northern Illinois University, De Kalb. Proceed north to Lucinda Avenue. Turn left (west).

0.4 Turn left (south) at stoplight onto Glidden Road. Proceed south across intersection with Illinois 38. We are on the Tiskilwa till plain surface, which in this area is characterized by ice-contact deposits and is covered with loess.

1.0 Note the large flat-topped "pingo" surface to the right (west); this elevated land surface is relatively circular and about a half mile in diameter. Pingos are dome-shaped mounds that develop under permafrost conditions and result from the uplifting of a layer of frozen ground by the pressure of water freezing in the substratum to form large ice lenses (Flemal et al., 1973). Flemal (1976) referred to these mounds as pingo scars or loess covered remains of pingos.

2.4 Turn left (east) on Fairview Drive, which runs parallel to Illinois 5 (toll road), and proceed east.

3.5 Turn right at stop sign and proceed south on Illinois 23.

6.5 Cross Elva Road. We are leaving the Tiskilwa till plain and passing onto subdued topography of the Shabbona Moraine, the outermost moraine of the Malden Till Member in this area. The more rolling, higher land ahead and to the left is the Arlington Moraine. Both moraines were included in the Cropsey Moraine on early maps. In the Arlington Moraine the Malden Till Member is relatively coarse and fits the concept of the Malden described by Willman and Frye (1970).

13.0 Cross Illinois 30. This flat area behind the Arlington Moraine probably formed as a lake plain.

14.0 Pass onto dissected Malden ground moraine, which contains ice-contact deposits.

16.0 Good view of the Farm Ridge Moraine across the valley straight ahead.

18.1 Cross Chicago Road on a broad outwash plain mapped as Equality Formation on the Quaternary deposits of Illinois map. These deposits are typically silt and sand.

19.8 Rise onto the Farm Ridge Moraine, which is composed of gray loam Malden Till here.

20.6 Cross over the crest of the Farm Ridge Moraine. Good view ahead of the lake plain of Lake Ottawa, a Woodfordian lake that formed between the Farm Ridge Moraine and the Marseilles Morainic System during the Kankakee Flood when flood waters from the Illinois and Fox River valleys spread over upland areas. The event is related to the general time of formation of the Valparaiso Morainic System. Much of the lake plain is not underlain by lacustrine sediments.

23.2 La Salle County line. A slope change here appears to be an erosional scarp and may represent a high water level beyond the mapped border of Lake Ottawa. Most of the soils in this area are developed in loess over loam till.

24.3 Turn right (southwest) onto U.S. 34 and Illinois 23. This area is mapped as Malden till plain but appears to be a lake plain, probably erosional in origin.

28.5 Turn left (south) onto Illinois 23. This is a gently rolling till plain with probable ice disintegration features.

33.1 Cross Indian Creek. Outwash is confined to the incised valley. The headwaters of Indian Creek are on the back side of the Arlington Moraine and the creek cuts through the Farm Ridge Moraine.

35.8 Join U.S. 52 and proceed straight ahead. Good view of the Marseilles Morainic System 5 miles to the southeast. We are on the border of what has been mapped as Lake Ottawa plain. Soils developed in outwash or sandy lacustrine deposits are common in the area south and east of here.

36.5 Turn left off U.S. 52 and Illinois 23 onto the gravel road (E 18) at the beginning of curve in the highway. Proceed south.

37.9 Jog in the road in small valley. Turn right and then left at the T-intersection and proceed south on the blacktop road.

39.0 Turn left onto Wedron Road (La Salle 21/35 N). We are on a nearly level part of the Lake Ottawa plain.

39.5 Turn right off the highway onto County Highway E 19 and head south into a tributary that has incised into the Lake Ottawa plain.

40.5 Turn left (east) onto gravel road. The Marseilles Morainic System is prominent on the horizon. The road curves to the south.

41.5 Turn left on what appears to be a lane to the house ahead. This is also a back entrance to Pit 6 of Wedron Quarry. Drive past the house and gate. We will walk from here if the road is not passable.

41.9 **Stop 1. Wedron Silica Company Quarry. New berm (road?) between pit 1 (300 m to the north) and Pit 6 (100 m to the south). When we leave, we may have to backtrack to Wedron Road. If the mine roads are passable, we will proceed through the operation area to the town of Wedron.**

42.9 Stop sign at plant entrance adjacent to the railroad tracks west of Fox River in Wedron. Turn right (east) and cross the Fox River.

43.1 The Wedron road curves south at this point and climbs a high Woodfordian terrace underlain by sand and gravel of the Henry Formation. Gravel pits are located on this surface along the Fox River.

44.1 The road curves to the east and rises on the distal slope of the Marseilles Morainic System composed of Yorkville Till. The outer 1 to 2 miles of the Marseilles Morainic System has subdued topography and is called the Norway Moraine.

45.9 Turn left onto Illinois 71 and proceed northeasterly.

48.9 The road parallels the front edge of the Ransom Moraine (the major moraine of the Marseilles Morainic System) to the right (east) for several miles. This moraine is one of the largest Woodfordian moraines in Illinois. Borings in the area indicate that the clayey Yorkville Till is up to 30 m thick locally and overlies the Malden and Tiskilwa Till Members.

51.0 Town of Norway, which was settled by Norwegians in 1834. Continue on Illinois 71.

53.3 Turn right (east) onto U.S. 52 and rise onto the Ransom Moraine.

56.0 Kendall County line. Descend into a large outlet channel of glacial Lake Wauponsee, the largest Woodfordian lake in northeastern Illinois. This was one of the overflow channels of a lake that formed between the Marseilles and Valparaiso Morainic Systems during the Kankakee Flood. Drainage was to the north at a right angle to the Marseilles Morainic System, which acted as a dam. The channel is about a half-mile wide at the estimated elevation of discharge (650 feet).

59.0 Descend the back side of the moraine onto a high lake level surface called Lake Lisbon plain. Lake Lisbon was the earliest and highest lake to form behind the moraine (650- to 700-ft altitude).

61.9 U.S. 52 curves to the north.

62.9 As U.S. 52 curves back to the east, it passes out onto the Lake Wauponsee plain, a nearly level surface that is at an altitude of about 650 ft here and slopes gradually to the southeast. The scarp between Lake Lisbon and Lake Wauponsee can be seen to the left (north).

65.4	Cross Illinois 47. Proceed east on U.S. 52. The Minooka Moraine is now visible straight ahead. Because of its arcuate shape, the Marseilles Morainic System is now to the north (left).
72.2	Cross Aux Sable Creek, which drains the northern part of the Lake Wauponsee plain.
74.2	Begin to rise onto the Minooka Moraine. This moraine is composed of clayey diamicton that contains slightly less illite and is less gray than Yorkville diamicton in the Marseilles. Although diamicton in the Minooka is currently mapped as Yorkville, we suggest that it is Wadsworth Till Member (see Epilogue).
78.4	Stoplight at Illinois 59. Proceed straight ahead and prepare to turn left into Hammel Woods park.
78.5	Turn left into park entrance.
79.0	**Lunch Stop. Hammel Woods park. Second picnic area with stone shelter.**
80.1	Park entrance. Turn left (east) onto U.S. 52 and cross the Du Page River.
80.6	Turn right onto entrance of Interstate 55 North.
82.2	Wind gap to the right. In the next few miles two more abandoned overflow channels from the Des Plaines Valley can be seen (miles 85.4 and 90.8). Overflow cut through the dissected Rockdale Moraine on the right and emptied into the Du Page River valley. The Des Plaines Valley to the east served as the outlet channel for drainage from glacial Lake Chicago.
93.5	Cross the Naperville Road underpass. The front of the West Chicago Moraine can be seen about a half mile ahead. The Wadsworth Till is the surface unit in the West Chicago Moraine, but the morainic topography may largely be a reflection of the Lemont drift (see Epilogue).
95.3	Exit south on Illinois 53. Abandoned Old Chicago recreation center is on the right. Continue ahead through the commercial area.
96.7	Turn right at the T-intersection and proceed southwest, parallelling the Des Plaines River, to Romeoville on Illinois 53.
99.0	Turn left onto Romeo(ville) Road in the commercial area north of the drive-in theater and head east to the bridge over the Des Plaines River and the two canals. Silurian dolomite is exposed in the Chicago Sanitary and Ship Canal just before the sharp jog in the road.
101.2	Cross the railroad tracks and turn left onto New Avenue (Lemont Road). Proceed north. The large refinery complex to the left was the site of several large explosions in 1984.

102.7 **STOP 2. Lemont Pit. Turn right and pass through the gate. Return to the pit entrance and turn left onto Lemont Road when leaving the pit.**

103.6 Turn left on the unmarked street (127th Street) opposite the Union 76 building. Rise out of the Des Plaines Valley onto Wadsworth Till of the West Chicago Moraine. In about a mile, rise again onto the Wheaton Moraine, which is also composed of Wadsworth.

106.1 Cross State Street. Continue east on 127th Street.

107.5 Turn left onto Illinois 171 and head northeast.

108.3 Turn right off Illinois 171 onto McCarthy Road heading east. Note kettle and kame topography. Many moraine distinctions are made on maps of this area, but are not apparent from the ground.

112.9 Turn left (north) onto 104th Street (Flavin Road) and proceed north.

113.4 Good view ahead as we descend into the Sag channel, the southernmost of two transmorainic channels that cross the Tinley Moraine and the Valparaiso Morainic System. During high lake phases, water in the Lake Michigan Basin drained south to the Illinois River by way of these channels (Sag and Des Plaines channels), which came to be known as the Chicago Outlet. Glacial lakes that drained via the Chicago Outlet include Lake Chicago (between about 14,500 and 11,000 B.P.) and probably Lake Milwaukee (a pre-Valparaiso lake). Lake Nipissing, a middle Holocene lake, also drained in part through the Chicago Outlet between about 6000 and 4000 B.P.

The Sag and Des Plaines channels each average about 1 km in width and about 22 m in depth. The valley floors of the channels have been altered considerably by the excavation of three canals (the Illinois and Michigan Canal, the Chicago Sanitary and Ship Canal, and the Calumet-Sag Channel), and by the diversion of the channel of the Des Plaines River. A core from the south side of the Sag channel one mile east of here revealed two peats separated by 80 cm of silt and clay. The upper peat yielded an age of 3390 ± 70 B.P. (ISGS-1240) and the lower peat an age of 8690 ± 80 B.P. (ISGS-1241). The lower peat was underlain by 50 cm of marl over bedrock. The lower peat and marl are attributed to sedimentation that postdates southern drainage from Lake Chicago, the silt and clay between the peats are attributed to sedimentation during Nipissing drainage through the channel, and the upper peat is attributed to sedimentation that postdates the Nipissing high lake phase.

114.1 Cross Illinois 83. Continue north on Flavin Road.

114.9 Cross 107th Street. Ascend onto Mt. Desert Island, the peninsula between the northern and southern channels of the Chicago Outlet.

117.4 Begin descent into the Des Plaines channel of the Chicago Outlet.

117.5	Cross Archer Avenue (Illinois 171). Proceed straight ahead across the Illinois and Michigan Canal, the Chicago Sanitary and Ship Canal, and the Des Plaines River. The road changes name to Willow Springs Road.
119.6	Cross over Interstate 294 (Tri-State Tollway) and Interstate 55.
120.4	Turn left on Joliet Road (U.S. 66) and head southwest toward Interstate 294. Cross Wolf Road and cross under Interstate 294.
121.2	Turn right to entrance of Interstate 294 (Tri-State Tollway) going north. Pass over Illinois 5 (Eisenhower Expressway).
129.8	Exit Interstate 294 to Interstate 290 (Tollway) west to Rockford. Many levels of highways and confusing curves. (No geology here that we know of.) Continue north on Interstate 290 to Interstate 90 (Northwest Tollway).
145.1	Exit Interstate 290 to Interstate 90 (Tollway) west to Rockford.
155.2	Pass under New Sutton Road (Illinois 59). In the next mile the clayey Wadsworth Till pinches out and the sandy Haeger Till Member is at the surface. No geomorphic feature helps to delineate this boundary except the generally higher morainal topography to the east. The Wadsworth here is a part of the undifferentiated Valparaiso Morainic System. Starting in this vicinity and continuing to the northwest, the West Chicago Moraine (or Woodstock Moraine, see Stop 3 discussion) is composed of Haeger Till. To the south the West Chicago Moraine is composed of Wadsworth.
156.7	Pass under Beverly Road. The Beverly Sand and Gravel pit (Stop 3) can be seen to the right.
158.4	Exit Interstate 90 to Illinois 25. Turn right and proceed north about 1/3 mile, passing under Interstate 90 and past the Howard Johnson's Motor Lodge. Prepare to turn just beyond the K-Mart.
159.4	Turn right (east) onto Brandt Drive. Follow the road to the entrance to Beverly Sand and Gravel and proceed through office area to the northeast corner of operations.
161.9	**STOP 3. Beverly Sand and Gravel pit. On leaving the pit retrace path back to Illinois 25.**
164.7	Turn left (south) on Illinois 25.
165.1	Turn left (east) at entrance to Interstate 90 west. Stay left following signs to Rockford (west bound).
167.6	Exit Interstate 90 onto Illinois 31 south.
168.4	Turn right onto Davis Road.
168.5	Rest Stop. Tyler Creek Forest Preserve.
168.61	Return to Illinois 31. Turn right and proceed south.

168.9 Turn right onto Big Timber Road and proceed west. Upland remnants here are mapped as Minooka Moraine and are underlain by Yorkville Till. New evidence suggests that the well-defined Minooka ridge east of the Fox River valley may have been formed during the Wadsworth phase. The moraine here is not contiguous with the Minooka ridge to the south, east of Fox River, and may have formed during an ice margin advance of the Yorkville phase.

169.4 Drop down into an outwash channel. The road rises in about a mile onto the Gilberts Moraine, an ice constructional-collapsed topography with kame-complexes, outwash, and lacustrine deposits related to a "late Tiskilwa" or an "early Malden" phase. The lithologies of the diamictons in this area are generally coarse and have variable clay mineral compositions.

176.1 Turn left (west) on Illinois 72 toward Starks.

179.1 Turn left (south) on combined Illinois Routes 72, 20, and 47.

179.5 Turn right (west) on Illinois 72. We leave the area underlain by lacustrine sediments and begin to rise on the backslope of the Marengo Moraine. The till in this ridge is distinctly reddish and has a medium-grained texture. It is correlated to the Tiskilwa Till.

184.4 Turn left onto French Road just beyond Hampshire and proceed south toward Burlington. This is the re-entrant area of the Marengo Moraine to the north and the Bloomington Morainic System to the west. The next 5 miles or so of the route have been included in the Elburn Complex, an area of hummocky topography characterized by ice-contact deposits (Willman and Frye, 1970).

186.9 Turn left at the T-intersection onto Burlington Road (Main Street) and in 0.1 mile turn right onto Plank Road (downtown Burlington) and head southwest.

192.8 Y-intersection with Moose Range Road. Continue ahead on Plank Road towards Sycamore.

194.8 Turn left (south) onto Illinois 23 and head south to Sycamore.

196.8 Turn right (west) on Illinois 23 and 64 in downtown Sycamore.

197.4 Turn left on Illinois 23 and proceed south out of town.

198.7 Turn right (west) onto Rich Road.

200.0 Turn left (south) onto North 1st Street into the north side of De Kalb.

201.5 Turn right (west) on Dresser Road.

203.0 Turn left (south) on Glidden Road.

204.1 Turn left (east) on Lucinda Avenue.

204.4 NIU Student Center. End. Have a safe trip home.

VALPARAISO
0 10 mi
0 15 km
BOONE
MCHENRY
LAKE
VALPARAISO (Undifferentiated)
WAUKEGAN
LAKE MICHIGAN
BELVIDERE
WOODSTOCK
West Chicago
Marengo
Huntley
Gilberts
Barlina
Fox Lake
Highland Park
Deerfield
Park Ridge
Blodgett
Tinley
DE KALB
KANE
COOK
stop 3
ELGIN
EVANSTON
LAKE BORDER
PP
LM
Paw Paw
La Moille
SYCAMORE
DE KALB
start
DU PAGE
GENEVA
St. Charles
Minooka
Roselle
Valparaiso
CHICAGO
Shabbona
Elburn Complex
AURORA
Keeneyville
Calumet Lake
KENDALL
WILL
stop 2
YORKVILLE
Ransom
Clarendon
Westmont
Tinley
Farm Ridge
MARSEILLES
stop 1
lunch
JOLIET
Manhattan
Wilton
Wheaton
Westmont
Chicago
Center
GRUNDY
Norway
MORRIS
OTTAWA
ILLINOIS RIVER
Farm Ridge
KANKAKEE
STREATOR
LIVINGSTON
3 4 5 6 7 8 9 10 11 12 13 14E
14 W 11E 12 11W